High Resolution Site Characterization Report – Ultra-Violet Optical Screening Tool

Client: Coleman Engineering

Project Name: Haskell Lake

Location: Lac du Flambeau, WI

Prepared by:

Dakota Technologies Company, LLC

11253 91st Avenue N.

Maple Grove, Minnesota 55369

763.424.4803

September 20, 2016

Project Number: 0221.16

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APPENDICES

1.0 ULTRA-VIOLET OPTICAL SCREENING TOOL (UVOST®) DESCRIPTION & ANALYSIS

Fluorescence is a property of some compounds where absorbed ultra-violet (UV) light stimulates the emission of photons (light) of a longer wavelength relative to the source emission. The release of the photons can be used to detect small amounts of substance (i.e., polycyclic aromatic hydrocarbons (PAHs)) in a larger matrix (soil). This method of detection has been used in laboratories for decades. With the commercial availability of lasers and optical fibers, this technology can also be applied in-situ in the field to identify the presence of light non-aqueous phase liquids (LNAPL).

The UVOST® system sends laser light (308 nanometer wavelength) through a fiber optic cable strung within probe rods on a direct push drill rig. The light, reflected by a parabolic mirror, then exits through a sapphire window in the side of the probe. As the probe is advanced, the immediately adjacent soil is exposed to the UV laser light. If PAHs (compounds in petroleum oils and lubricants that fluoresce) are present, longer wavelength light is emitted by the PAH compounds. This "signal" light is transmitted through a return fiber, back to the surface to be analyzed. Responses are indicated in real-time on a graph of signal vs. depth. The UVOST® log displays "color mixed" signal logs consisting of contributions from four wavelength channels, and waveforms ("fingerprint" of multi-wavelength) to aid in identification and relative quantity of the compound present.

Prior to every log, the UVOST® system is checked for optical quality by observing the background signal for sources of signal in the fiber, filter, mirror and sapphire window. Also, the reference emitter (a standard, proprietary LNAPL mixture called the "RE") is placed on the window to determine the qualitative and semi-quantitative properties of the laser system. This is to assure that the RE response has the correct shape and intensity and that the UVOST® system is calibrated to log. Typically, the RE will fall between 10,000 and 12,000 picovolt-seconds (pVs), which is a measure of waveform area. The background can vary from 0.1% to 1%, which is typically an area of approximately 0 to 100 pVs. The relationship between the instrument responses from NAPL in the subsurface and the RE depends on the properties of the NAPL. The calibration of the system is not to a concentration, but to a known fluorescence signature.

2.0 ELECTRICAL CONDUCTIVITY (EC) DESCRIPTION

Electrical Conductivity (EC) data were collected simultaneously with the UVOST® data. EC is a measure of the soil's ability to conduct an electrical current between two dipoles on the UVOST/EC probe. Conductivity is the reciprocal of electrical resistivity and has the units (in our application) of millisiemens per meter (mS/m). Since soil is in the pathway of the charge flow, the grain size can be determined by comparing the EC log to lithology observed in a soil boring. Conductivity readings in the 100s indicate smaller grain (size such as clay). Larger grain size (sand and gravels) are typically in the 10s of mS/m range. Prior to every log, the EC point of the UVOST® probe is checked for proper operation by performing a voltage test with a voltage meter and a conductivity test with a test block.

3.0 DISCUSSION AND COMMENTS

Dakota Technologies completed 20 UVOST® borings on the property.

LNAPL was observed on most logs between approximately 5 and 15 feet identified by UVOST®.

LIF-01A and LIF-04A are borings that were done near borings that hit refusal at shallow depths. We were able to advance deeper on these borings by pre-probing to 12 feet with a 2 inch solid point.

All QA/QC passed specifications for all UVOST® logs.

No soil sampling was completed for confirmation of EC data (soil type) and UVOST® (LNAPL) findings.

4.0 LIMITATIONS

The analysis and opinions expressed in this report are based upon data obtained from the specific test locations and from other information discussed in this report. Exceptions, if any, are discussed in the accompanying comments section of this report. This report is prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted practices. Reported results shall not be reproduced, except in full, without written approval of Dakota. No warranties, expressed or implied are intended or made.

Appendix A

UVOST® Field Summary Log

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UVOST® Field Summary Log

Haskell Lake

Lac du Flambeau, WI

File Log ID	Date / Time	Pre-Probe *(ft)*	Final Depth *(ft)*	Max Signal *(%RE)*	Max Signal Depth *(ft)*	Initial RE Area *(pVs)*	Background Area *(pVs)*	Fluorescence[(1)] Top - Bottom *(ft)*
LIF-01	9/7/2016 10:00	3	7	23	7	11489	0	6.8-7.5
LIF-02	9/7/2016 11:45	3	30	20	12	11788	17	7.7, 10.2, 11.8-12.7
LIF-03	9/7/2016 12:49	3	15	81	11	11407	24	11.3-11.4, 12.2
LIF-04	9/7/2016 15:35	12	9	16	8	11739	20	7.8
LIF-05	9/7/2016 16:32	12	26	4	0	10983	27	6.0-8.6
LIF-06	9/7/2016 17:13	12	28	45	8	10637	20	7.5-7.7
LIF-07	9/8/2016 8:37	12	26	24	12	11467	8	6.8-9.2, 9.8-12.8
LIF-08	9/8/2016 9:21	12	32	5	12	11382	20	9.9-12.0
LIF-09	9/8/2016 11:11	12	30	5	12	11871	20	10.4-11.9
LIF-10	9/8/2016 12:44	12	14	1	9	11266	21	NA
LIF-11	9/8/2016 13:24	12	8	1	2	11482	22	NA
LIF-12	9/8/2016 13:51	12	15	70	12	11927	27	7.6-9.2, 12.1
LIF-13	9/8/2016 14:49	12	27	122	13	11256	27	10.6-12.9
LIF-14	9/8/2016 15:38	12	18	67	8	11694	29	6.5-9.3, 12.6-12.8
LIF-15	9/8/2016 16:27	12	14	94	7	11467	20	6.8-8.4
LIF-16	9/8/2016 17:11	12	15	7	12	11234	18	NA
LIF-17	9/8/2016 18:08	12	15	3	3	11424	22	2.8-7.0
LIF-18	9/8/2016 18:31	10	10	11	9	11181	25	8.4-8.7
LIF-1A	9/7/2016 14:35	12	26	20	8	11231	13	7.3-7.7, 11.9
LIF-4A	9/8/2016 11:54	12	15	51	8	11413	17	6.3-8.8
	Total Footage (this sheet)		**381**					

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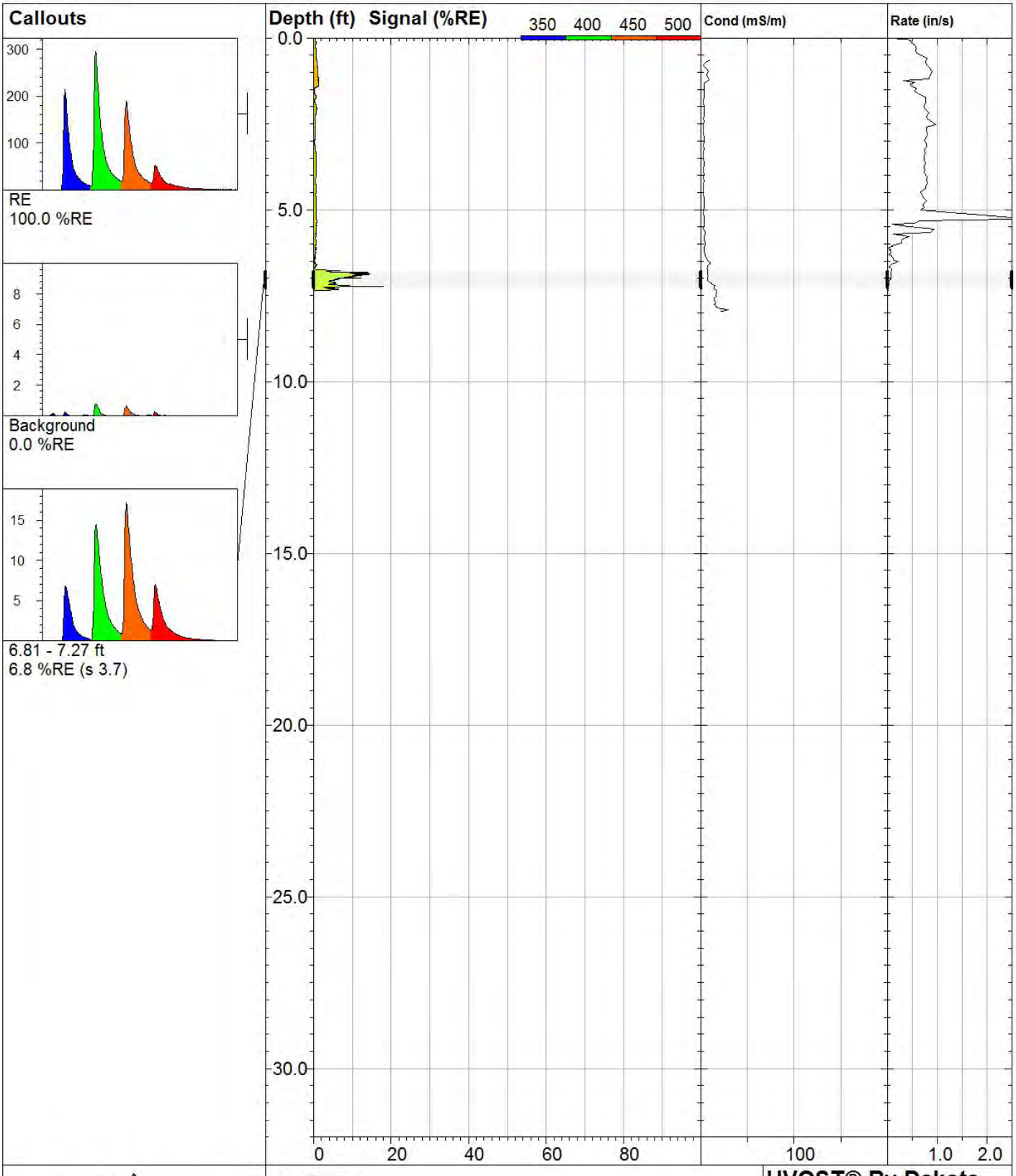
Appendix B

UVOST® Logs at 100% RE



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LIF-01

UVOST® By Dakota
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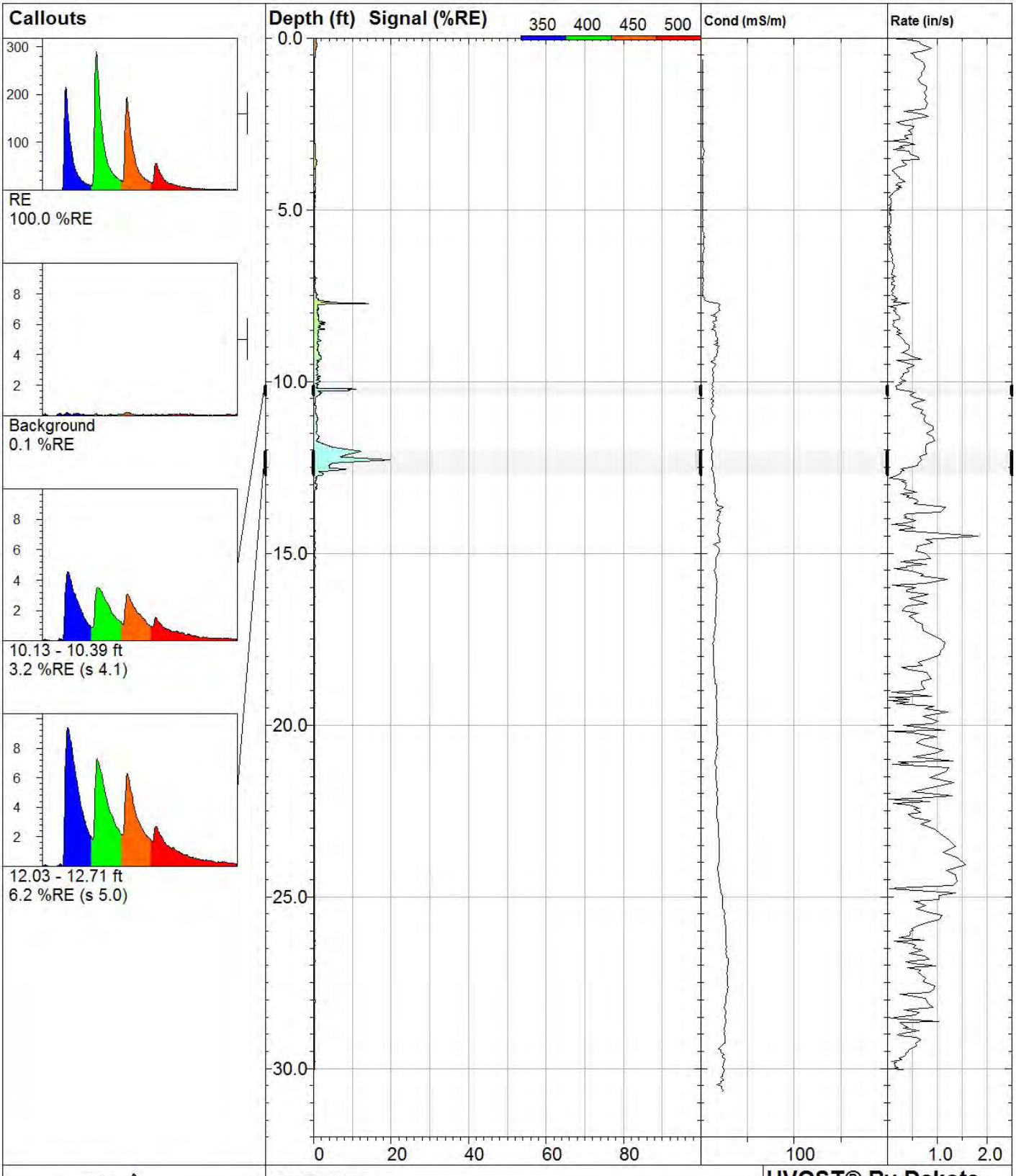
Site: **Haskell Lake**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **7.35 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **22.7 %RE @ 7.24 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 10:00 CDT**



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LIF-02

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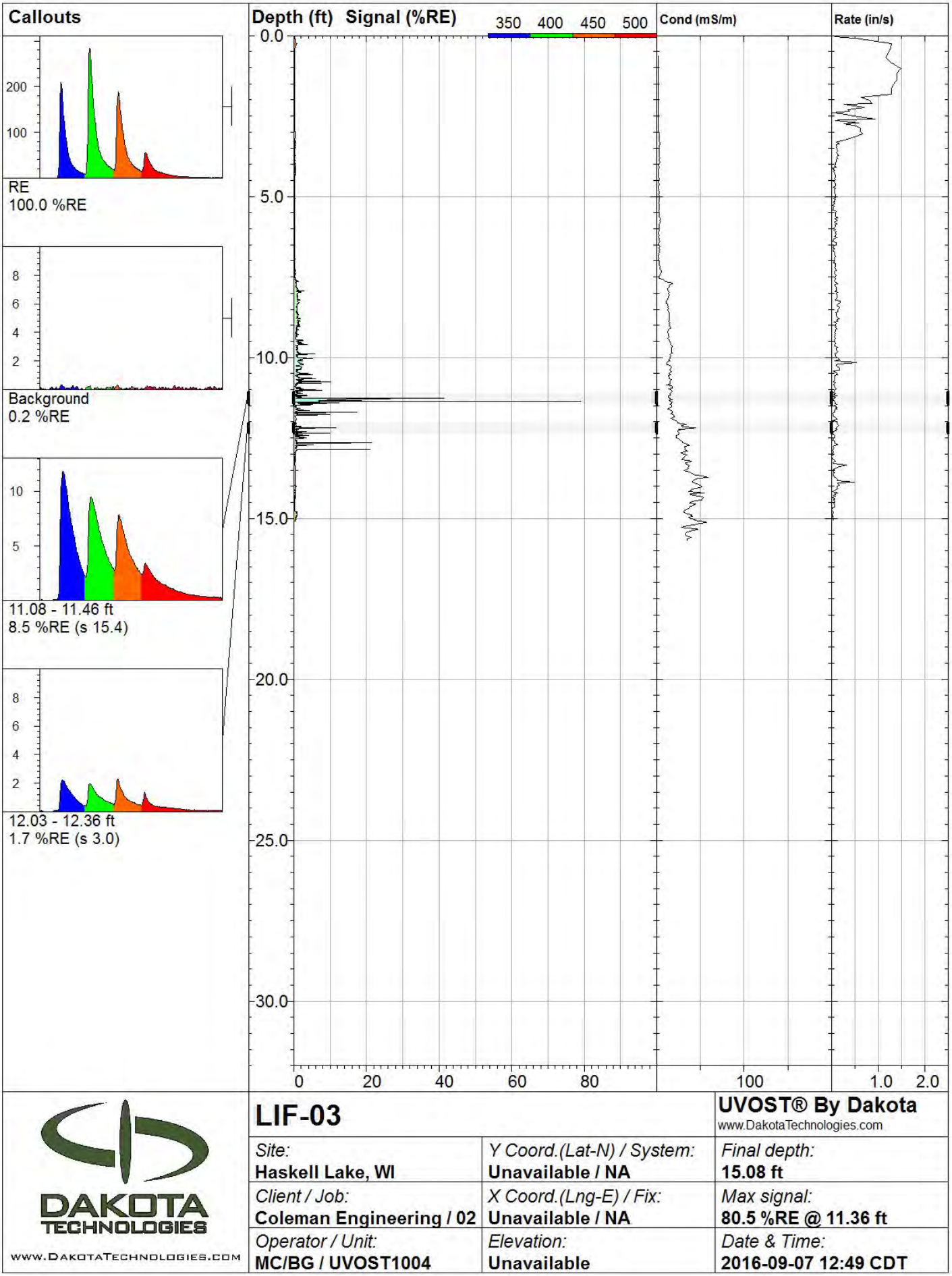
Site: **Haskell Lake**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **30.04 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **19.9 %RE @ 12.28 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 11:45 CDT**



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LIF-03

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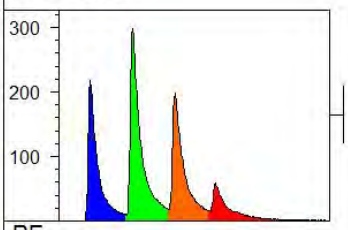
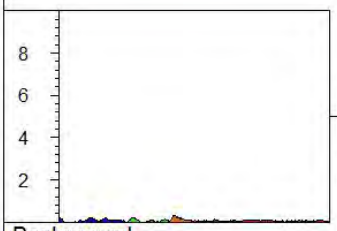
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **15.08 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **80.5 %RE @ 11.36 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 12:49 CDT**

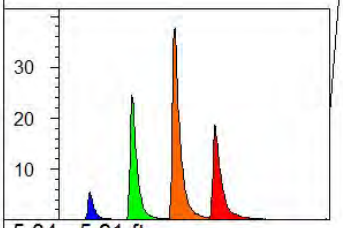
Callouts



RE
100.0 %RE



Background
0.2 %RE



5.34 - 5.91 ft
7.7 %RE (s 2.7)

Refusal at 9.00 feet.

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LIF-04

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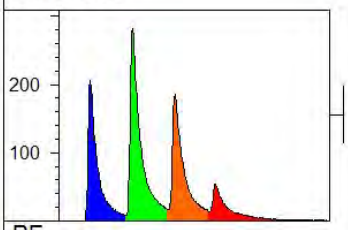
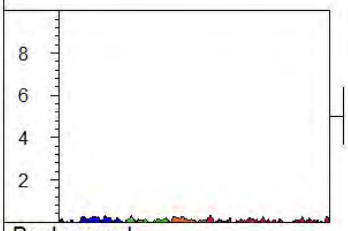
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **9.00 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **15.7 %RE @ 7.75 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 15:35 CDT**

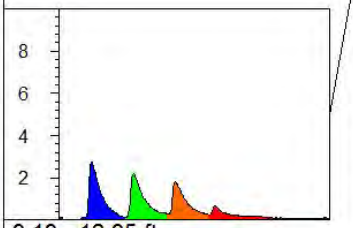
Callouts



RE
100.0 %RE

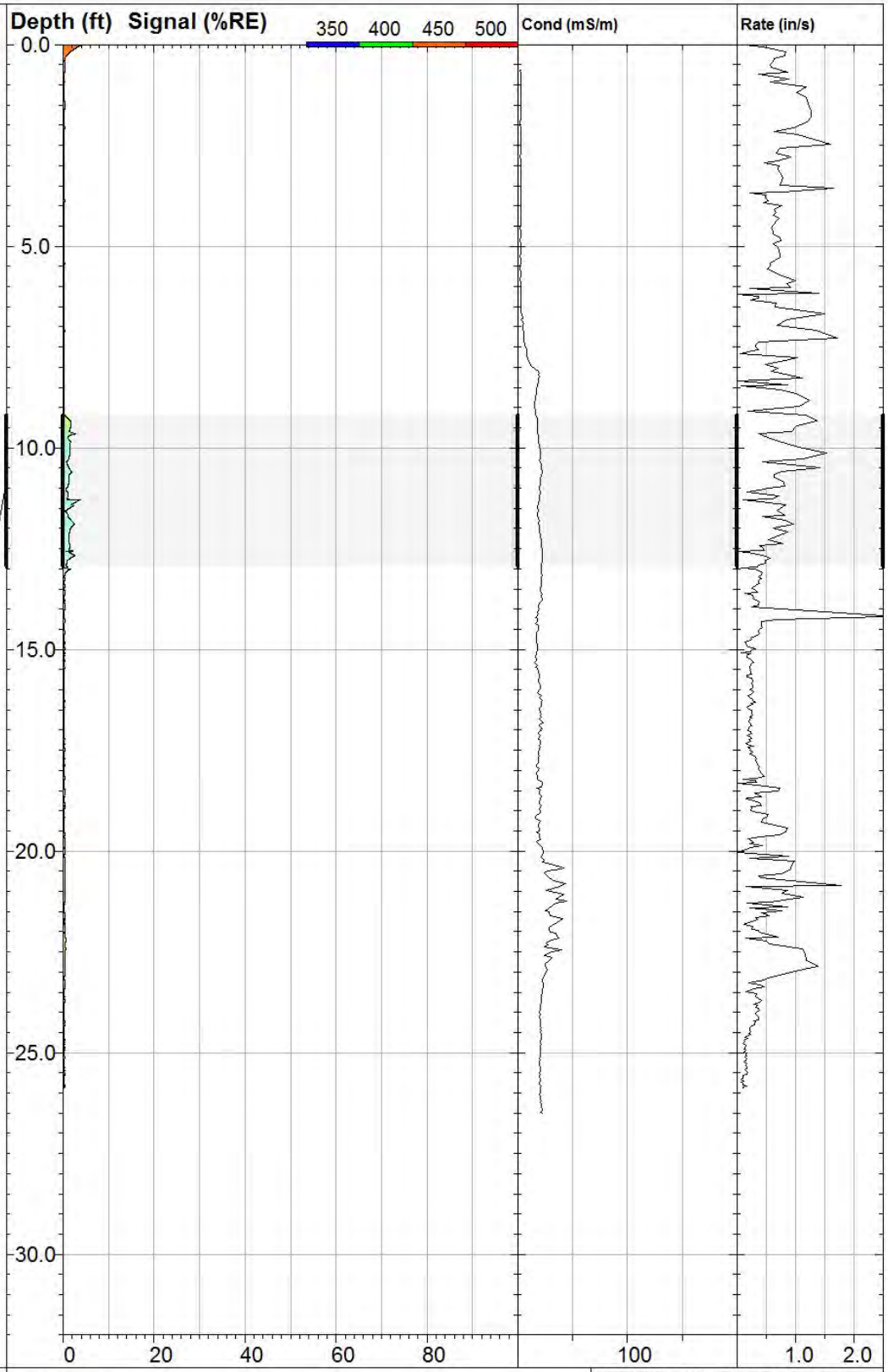


Background
0.2 %RE



9.19 - 12.95 ft
1.4 %RE (s 0.7)

Refusal at 9.00 feet.



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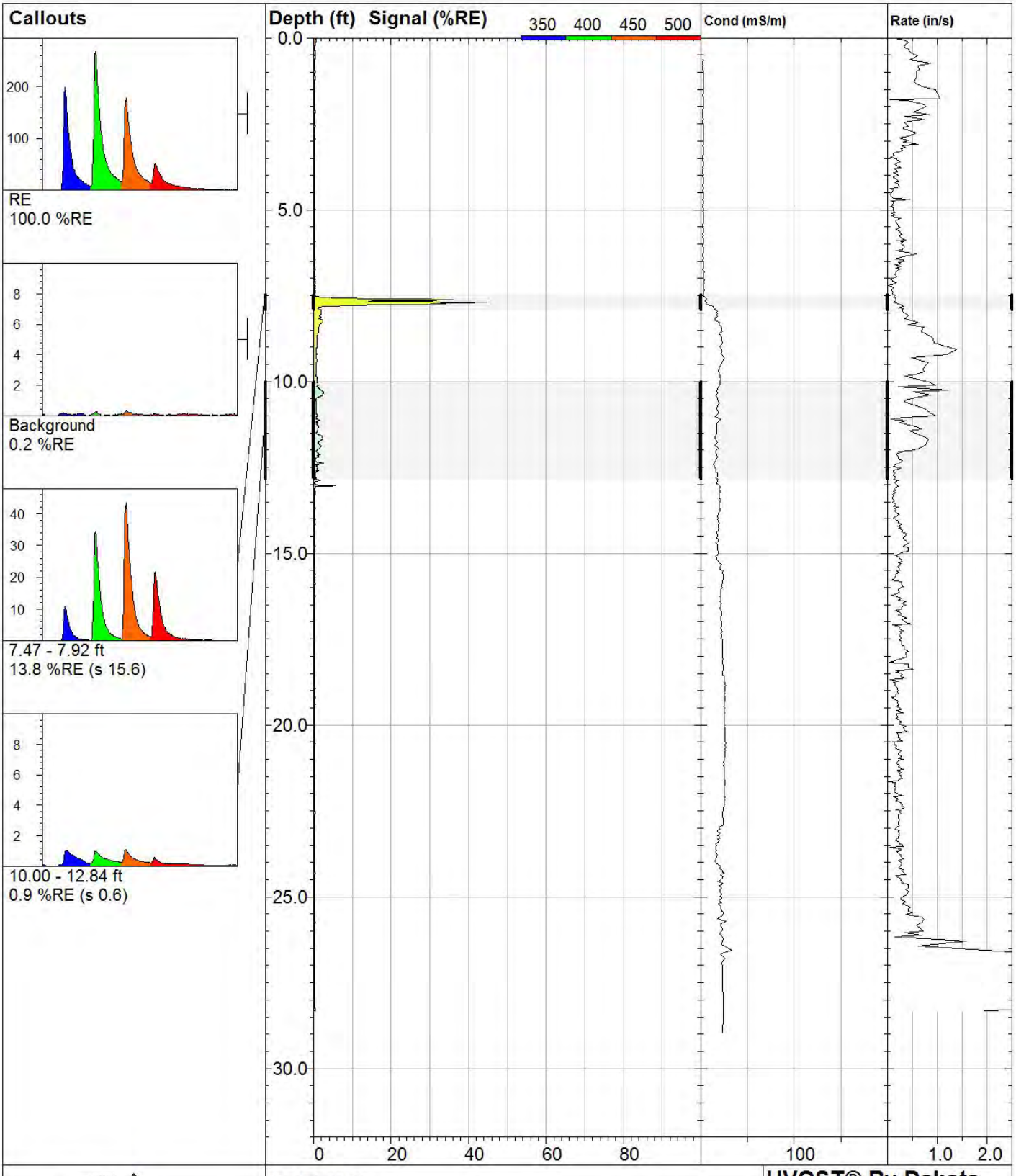
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **25.88 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **4.3 %RE @ 0.01 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 16:32 CDT**



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LIF-06

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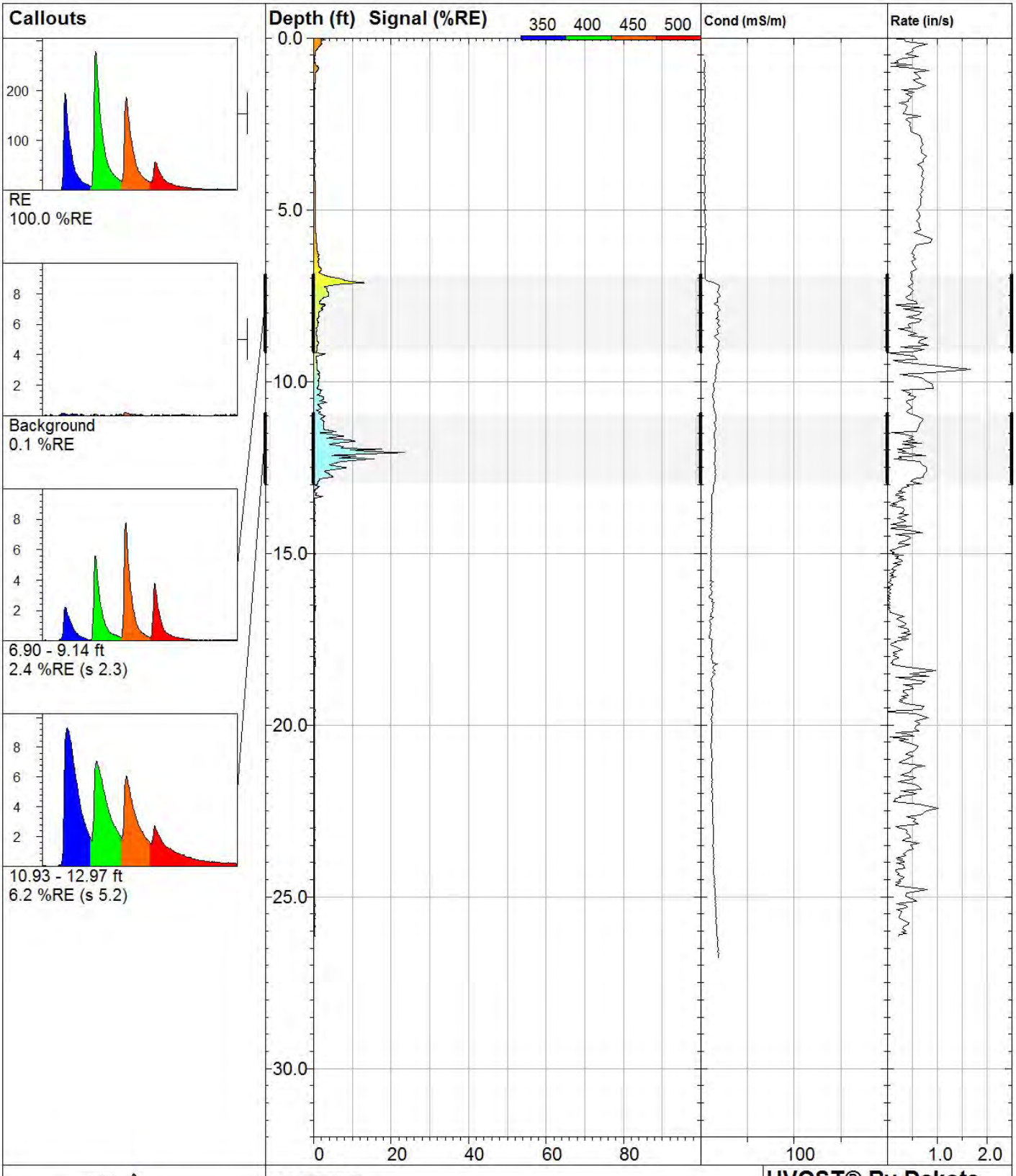
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **28.32 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **44.8 %RE @ 7.70 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 17:13 CDT**



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LIF-07

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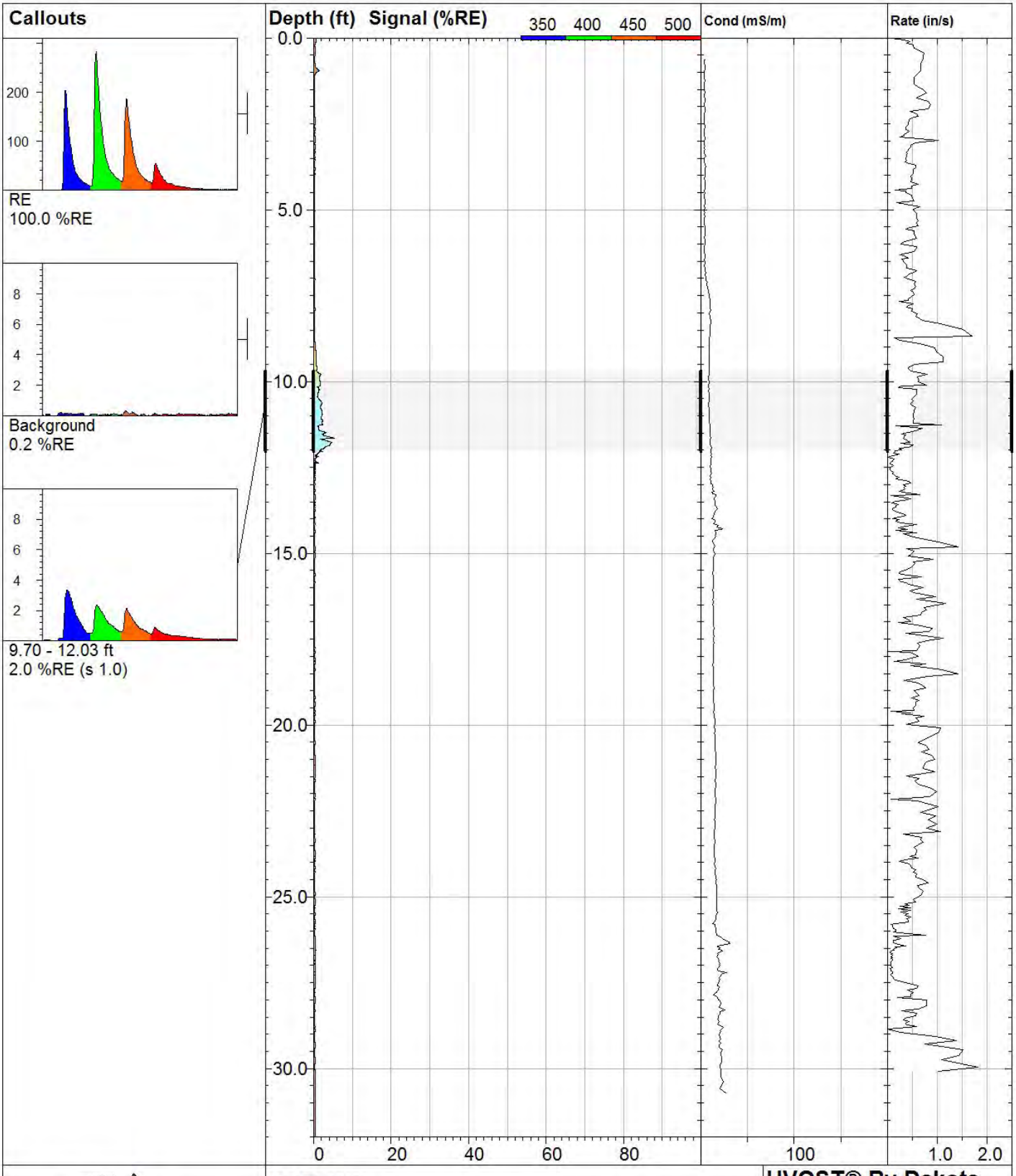
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **26.16 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **23.6 %RE @ 12.07 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 08:37 CDT**



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LIF-08

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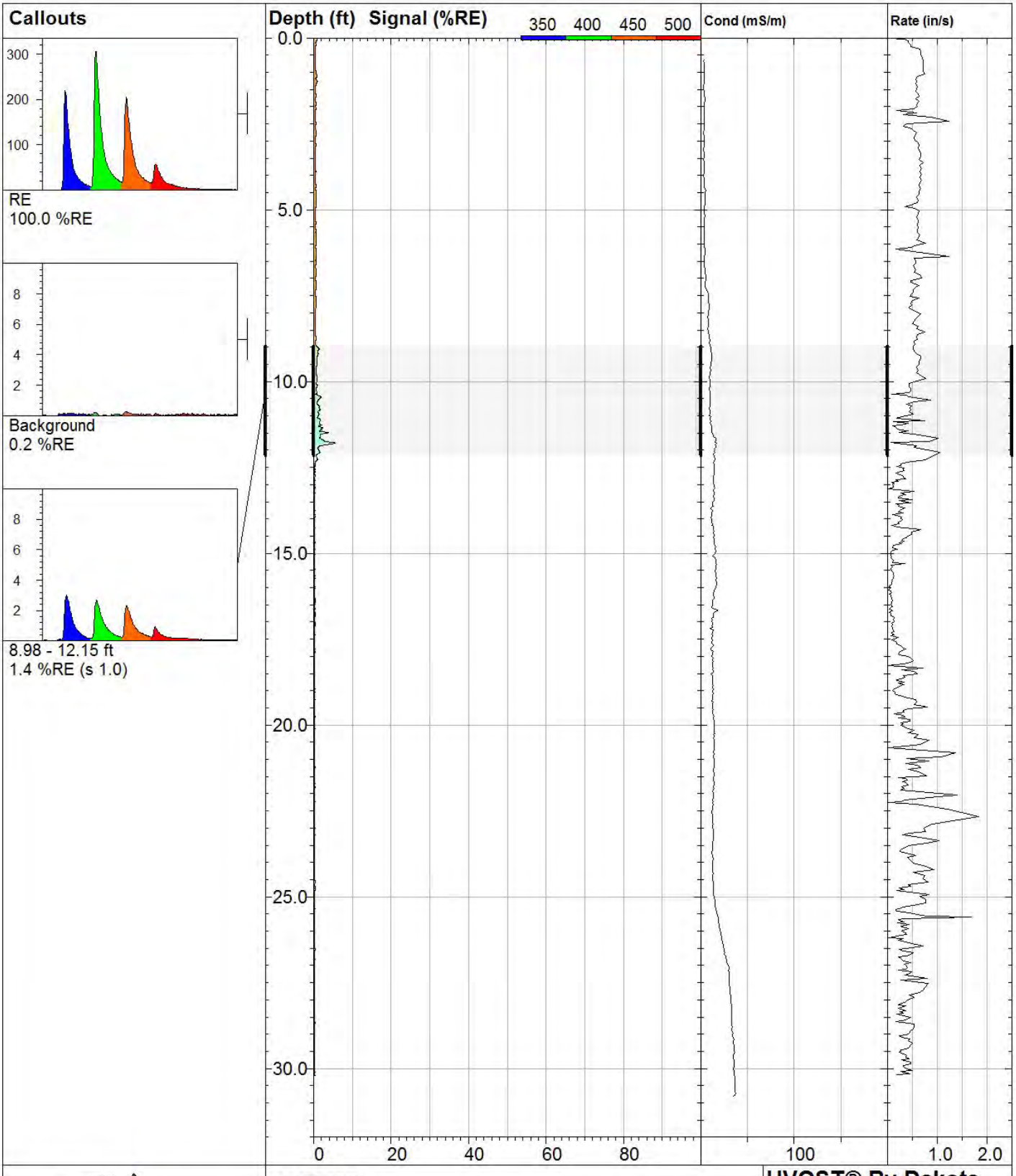
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **32.13 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.4 %RE @ 11.65 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 09:21 CDT**



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LIF-09

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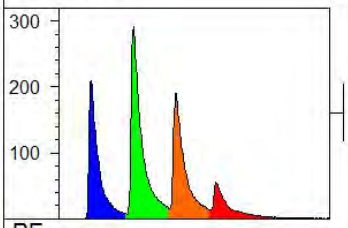
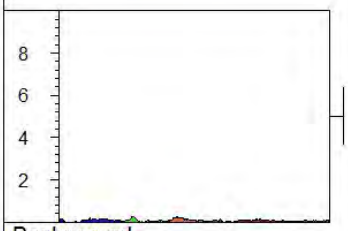
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **30.21 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.5 %RE @ 11.78 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 11:11 CDT**

Callouts

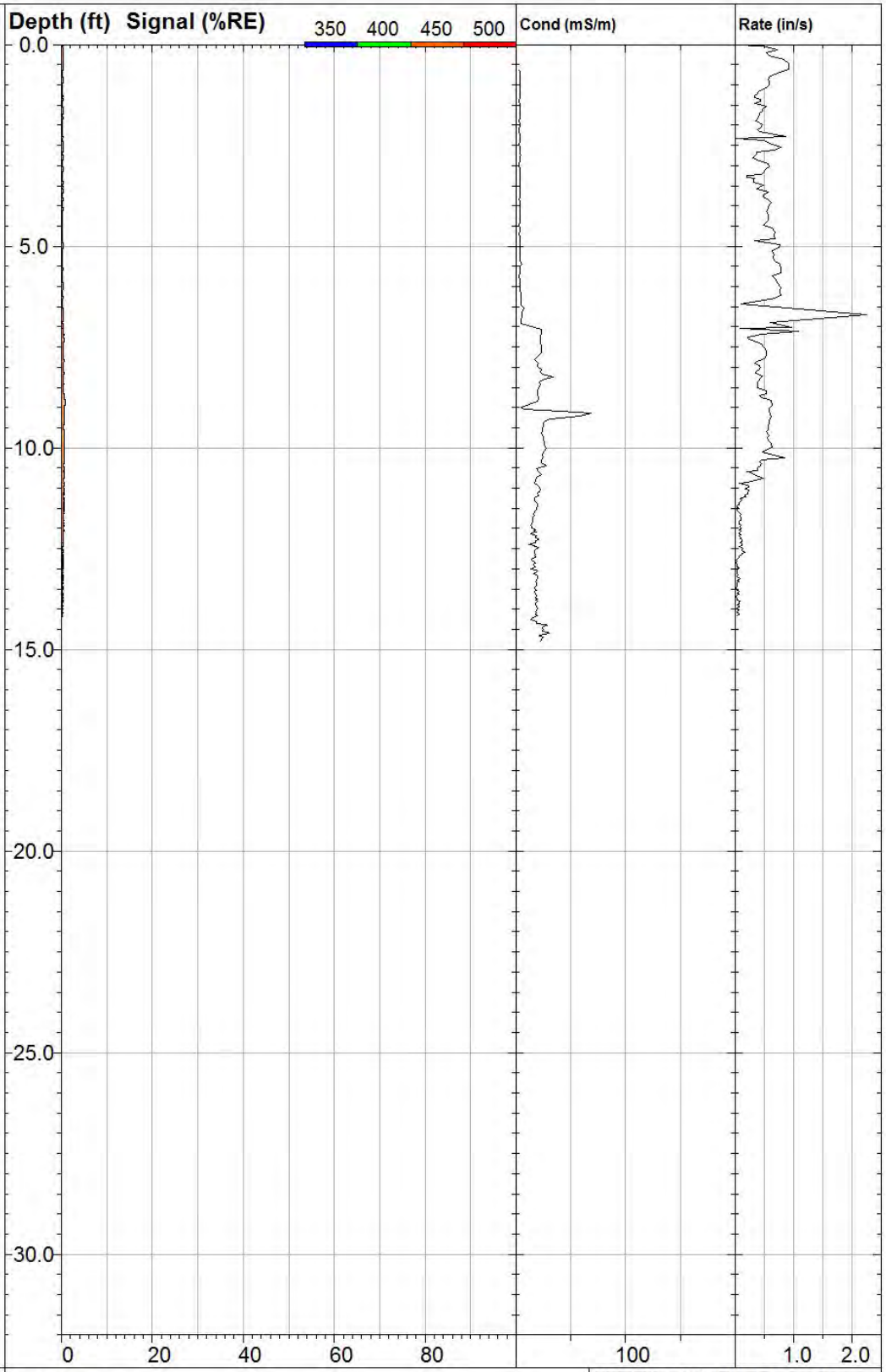


RE
100.0 %RE



Background
0.2 %RE

Refusal at 14.18'.



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LIF-10

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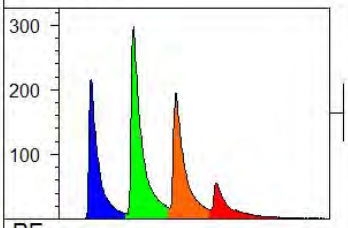
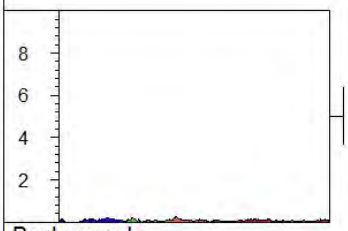
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.18 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **0.8 %RE @ 8.82 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 12:44 CDT**

Callouts

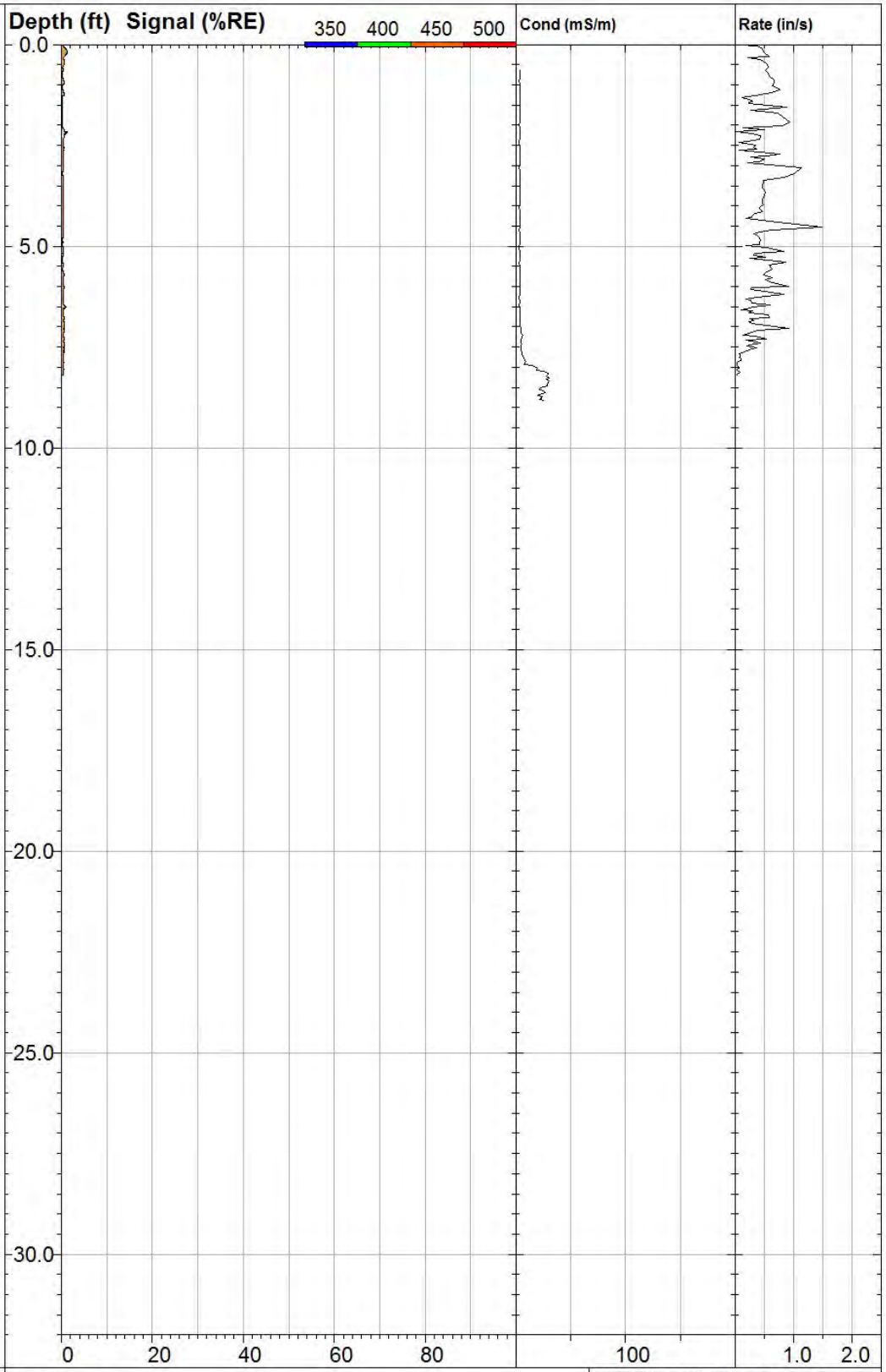


RE
100.0 %RE



Background
0.2 %RE

Refusal at 8.20 feet.



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LIF-11

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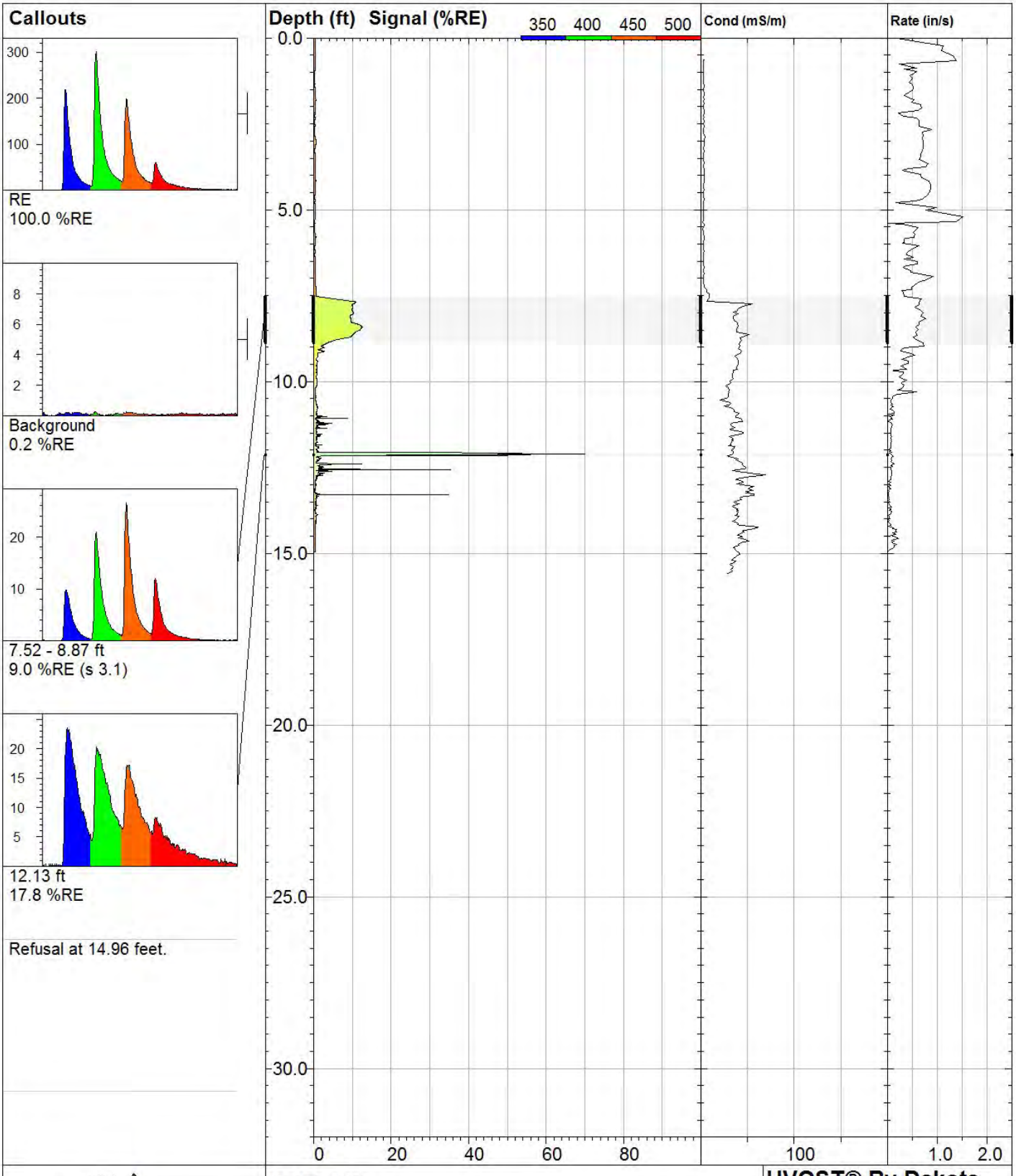
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **8.20 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.4 %RE @ 2.16 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 13:24 CDT**



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LIF-12

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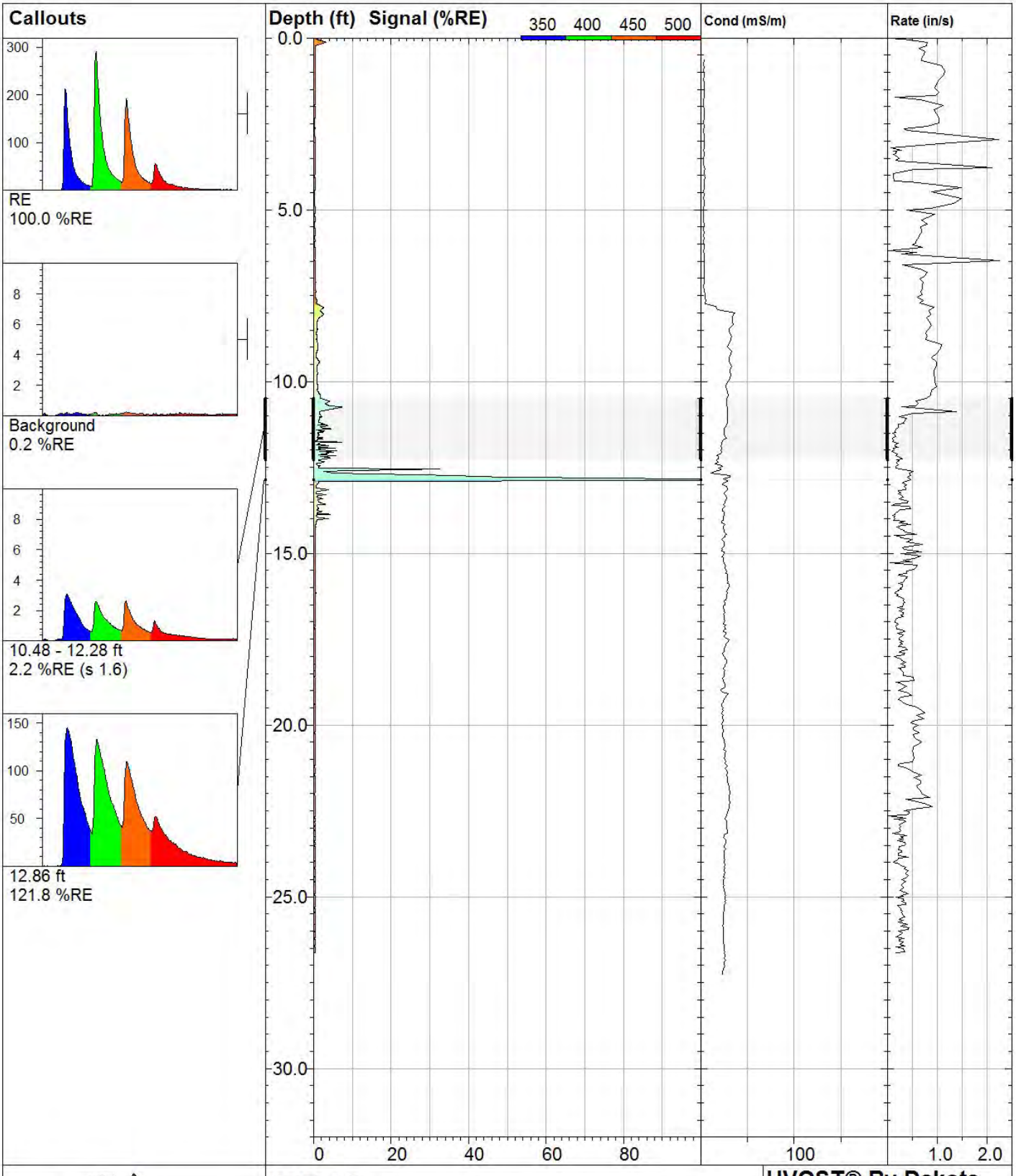
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.96 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **70.2 %RE @ 12.12 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 13:51 CDT**



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LIF-13

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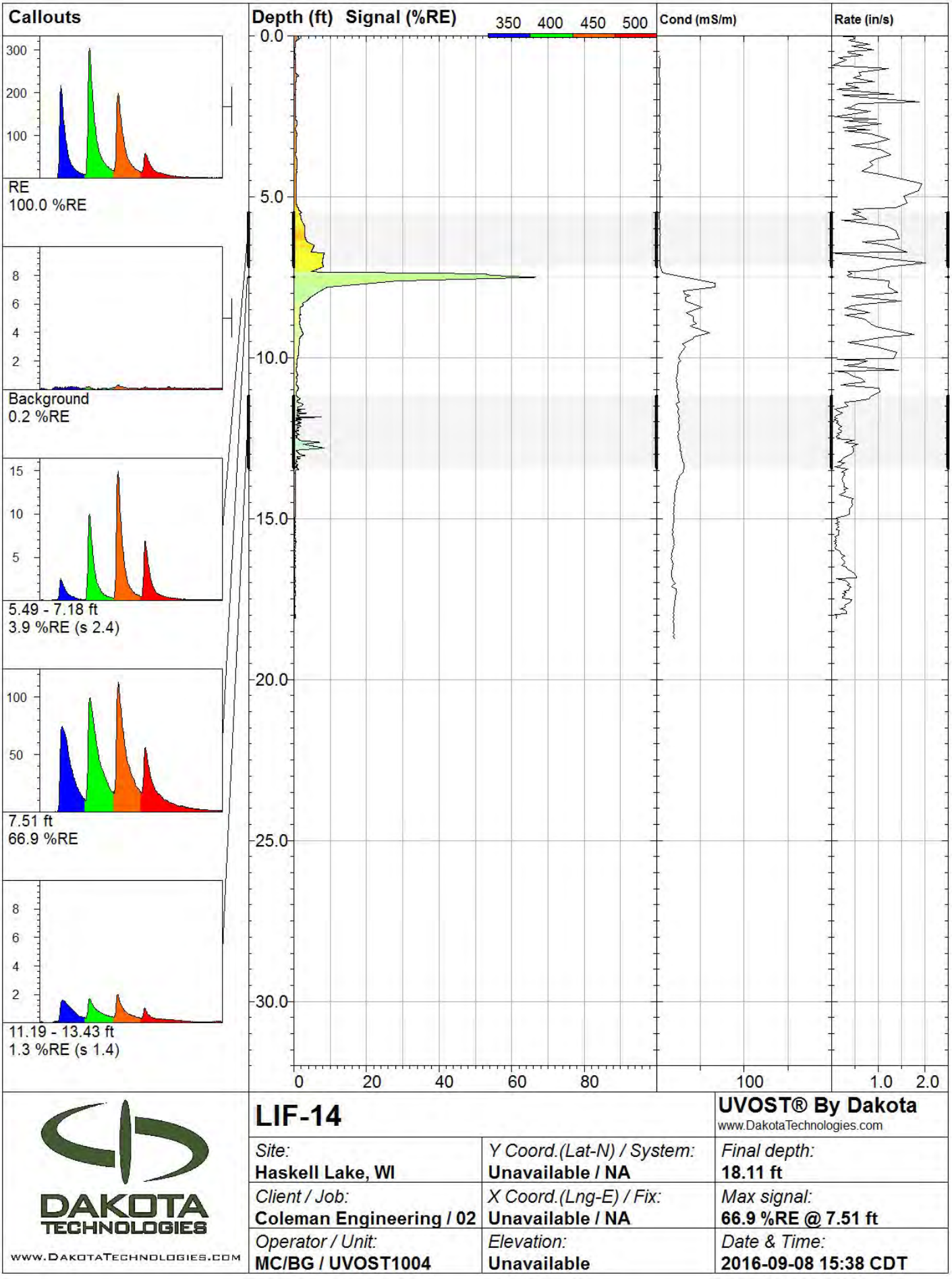
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **26.62 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **121.8 %RE @ 12.86 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 14:49 CDT**



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LIF-14

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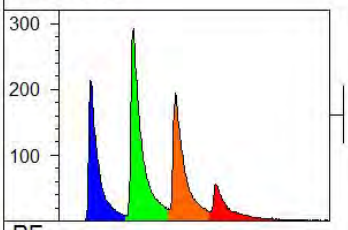
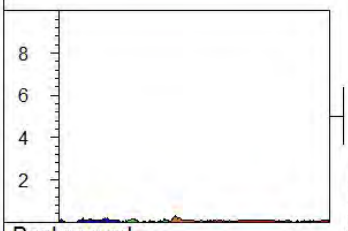
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **18.11 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **66.9 %RE @ 7.51 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 15:38 CDT**

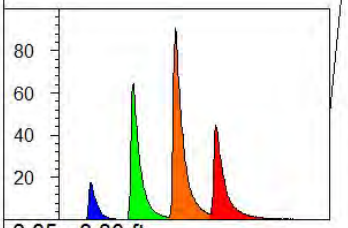
Callouts



RE
100.0 %RE

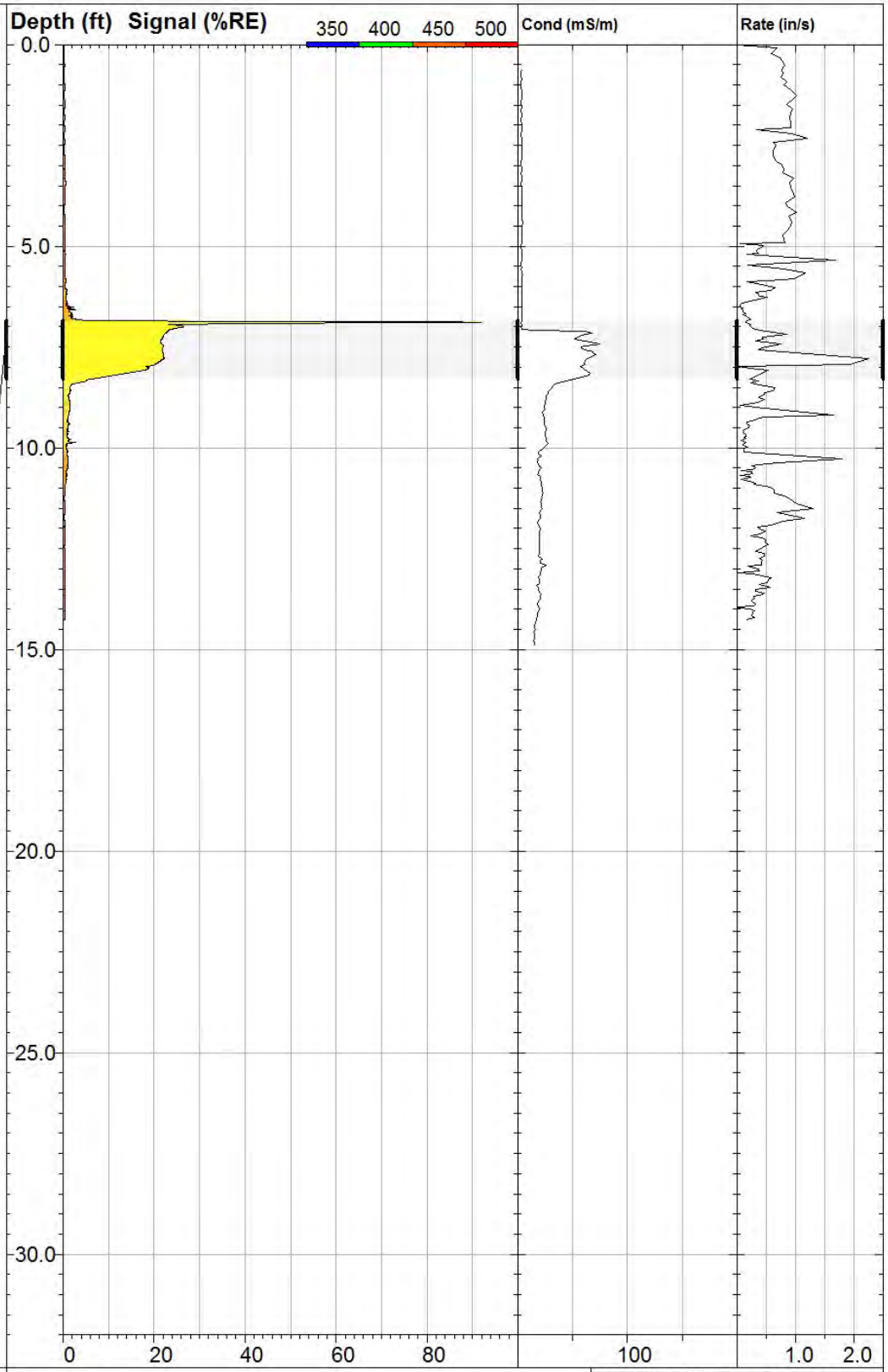


Background
0.2 %RE



6.85 - 8.30 ft
25.2 %RE (s 16.4)

Refusal at 14.27 feet.



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LIF-15

UVOST® By Dakota
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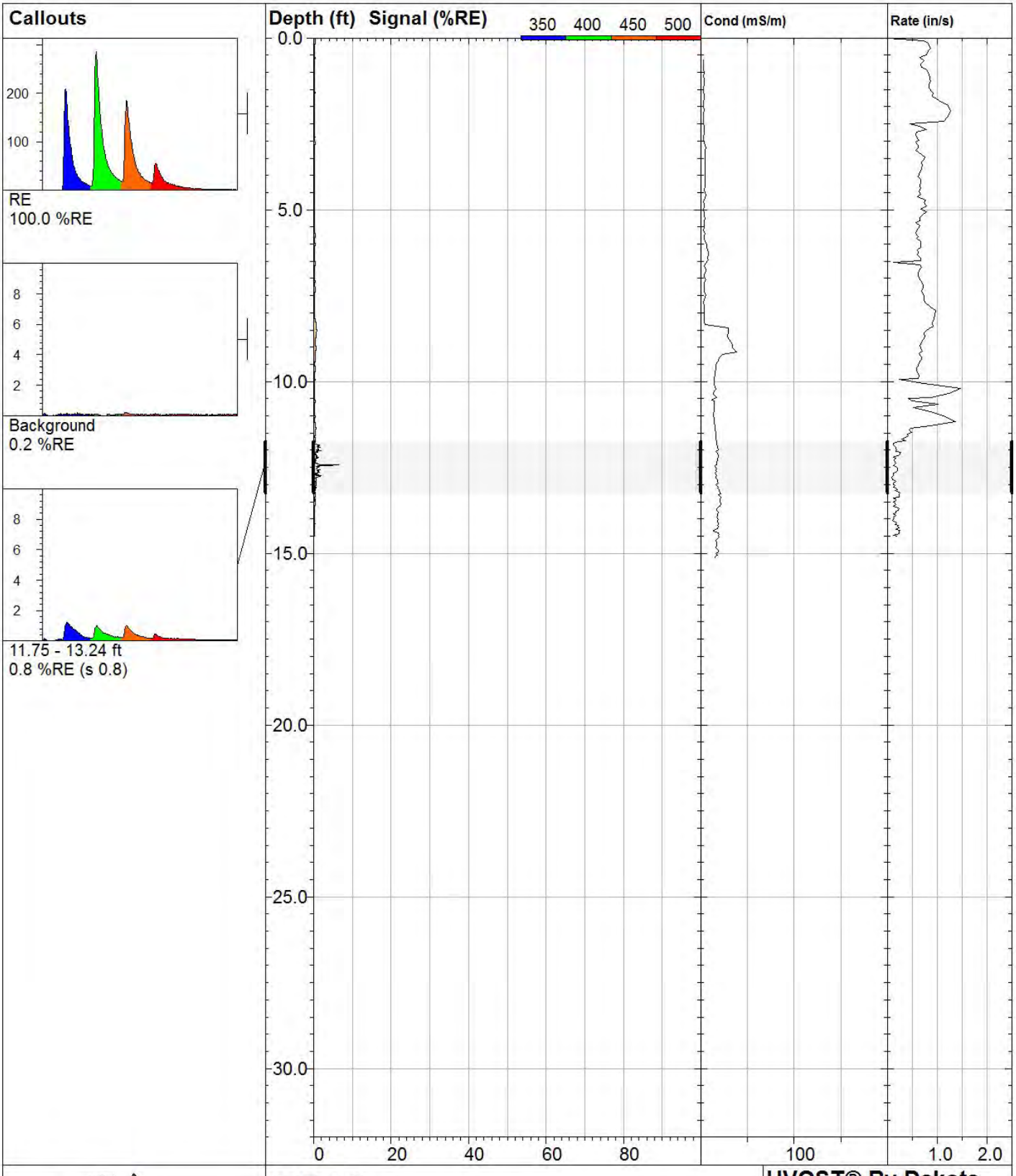
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.27 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **93.5 %RE @ 6.88 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 16:27 CDT**



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LIF-16

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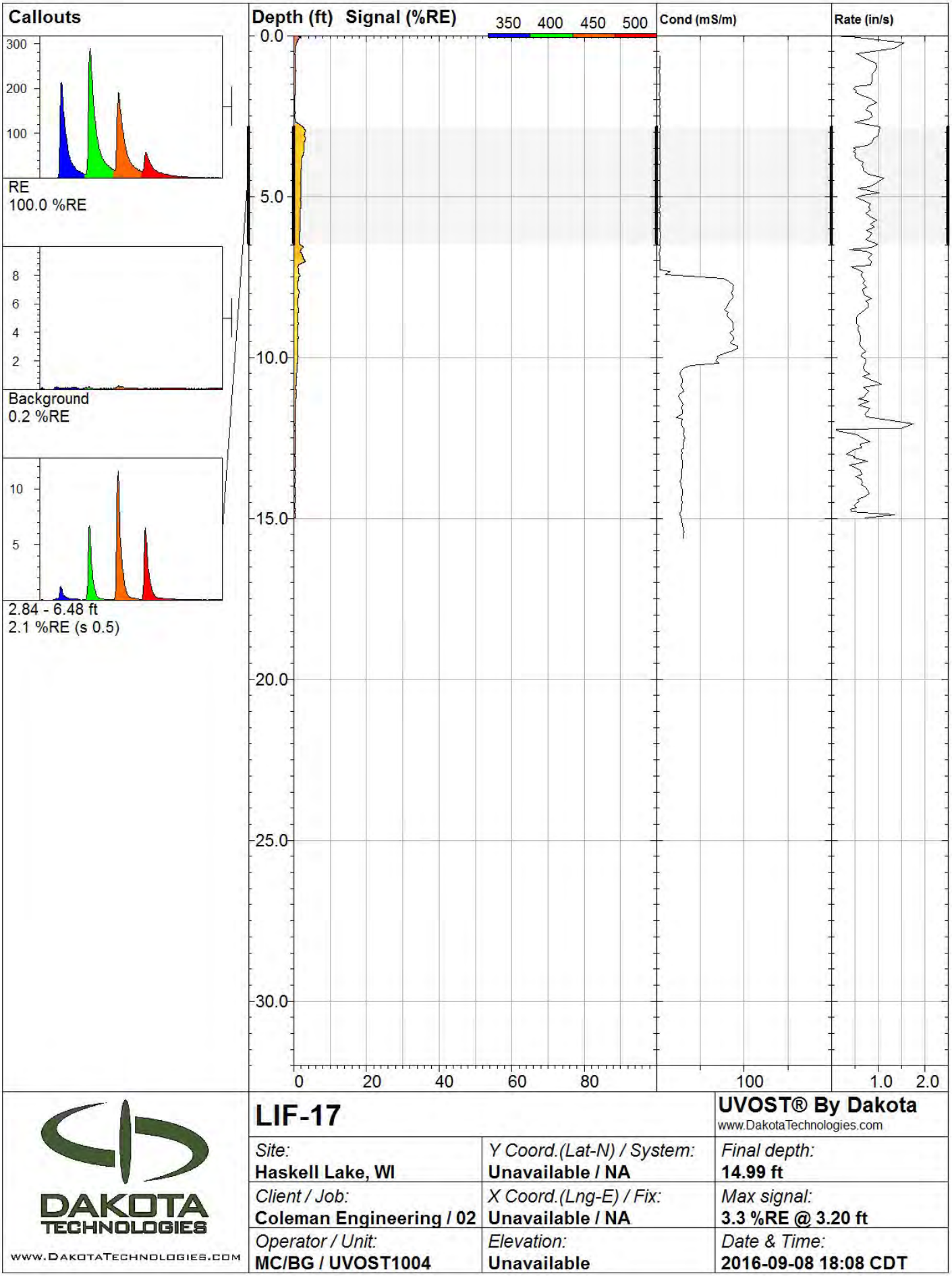
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.51 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.7 %RE @ 12.43 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 17:11 CDT**



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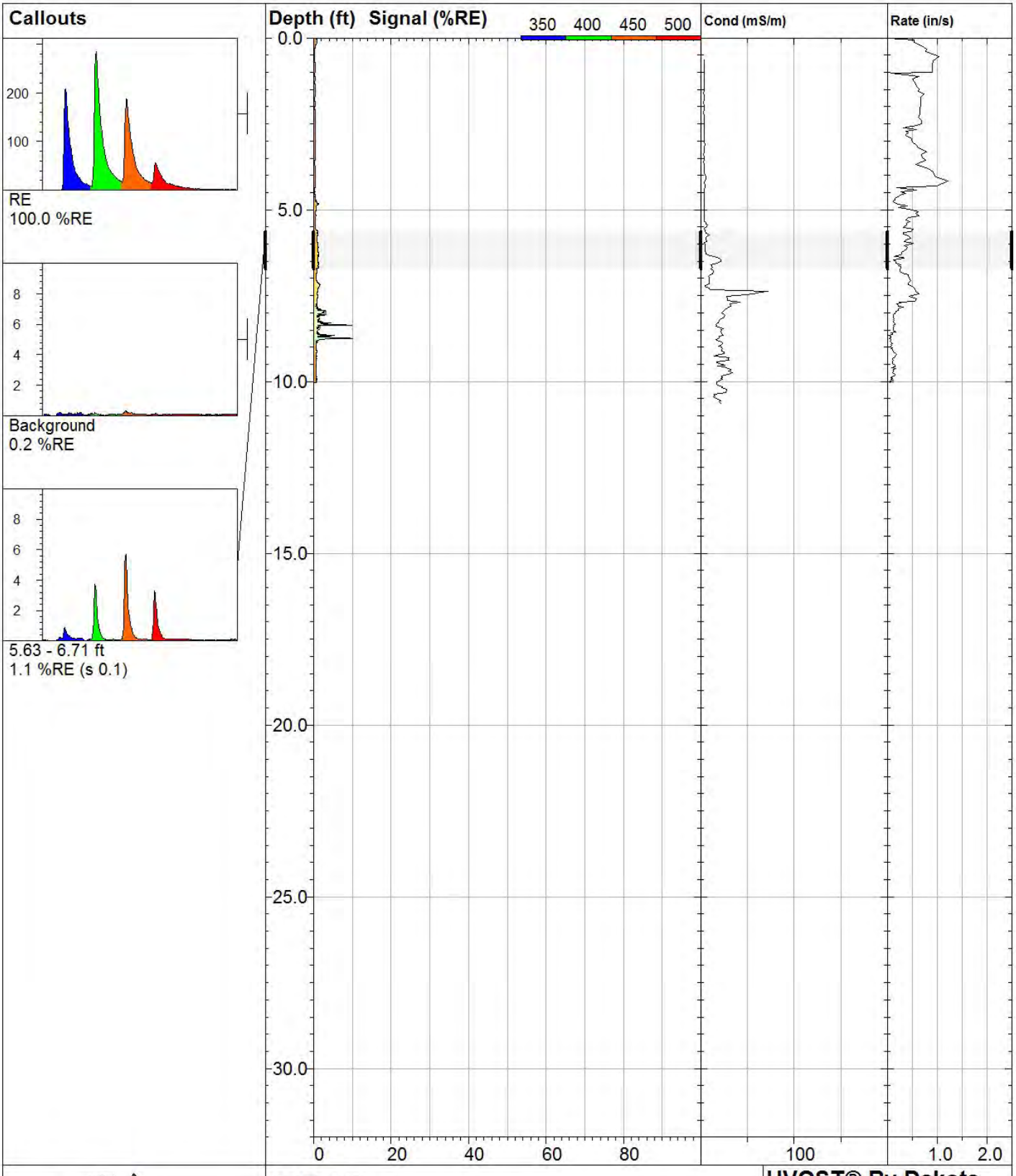
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.99 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **3.3 %RE @ 3.20 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 18:08 CDT**



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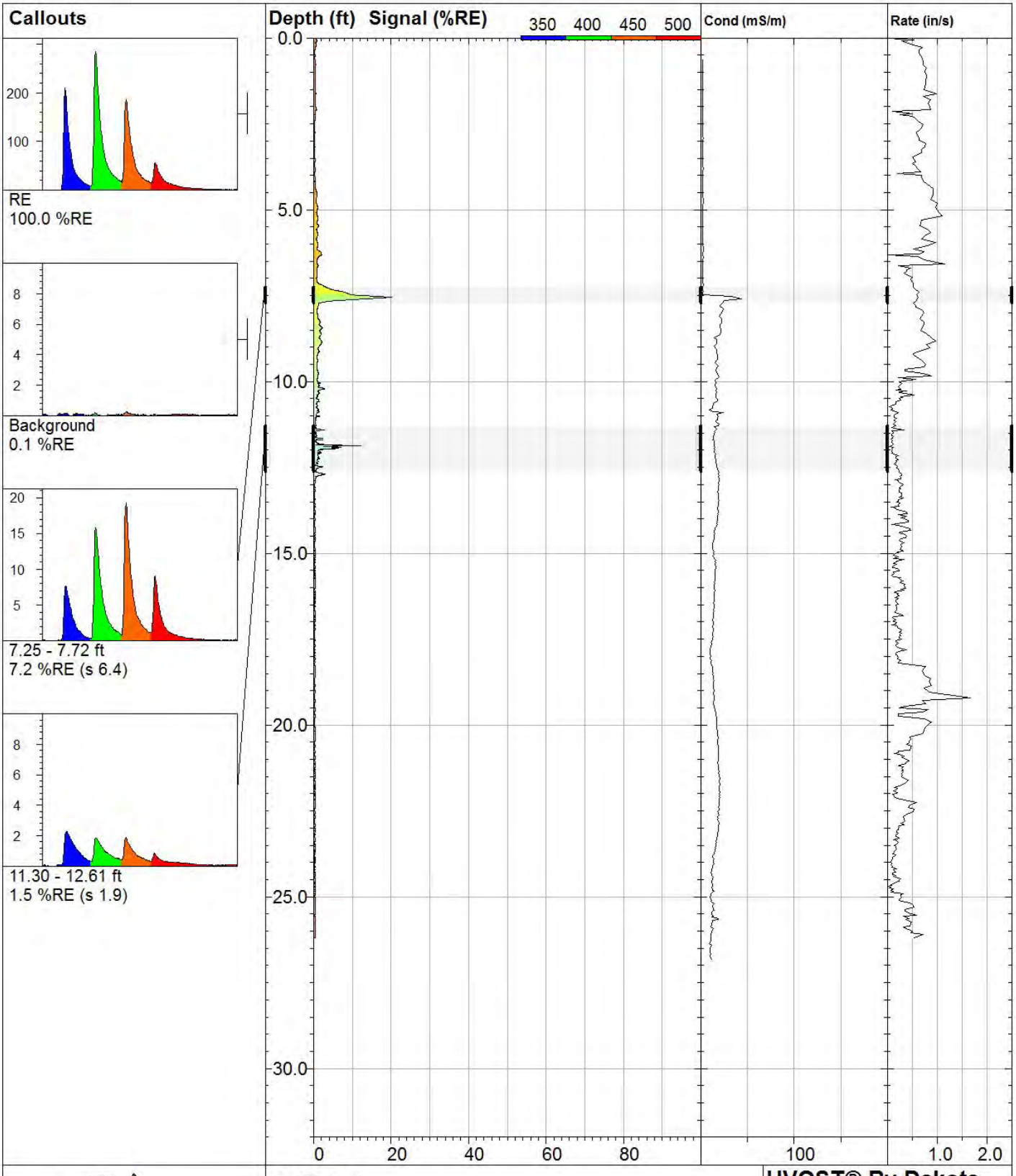
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **10.04 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **10.6 %RE @ 8.74 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 18:31 CDT**



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LIF-1A

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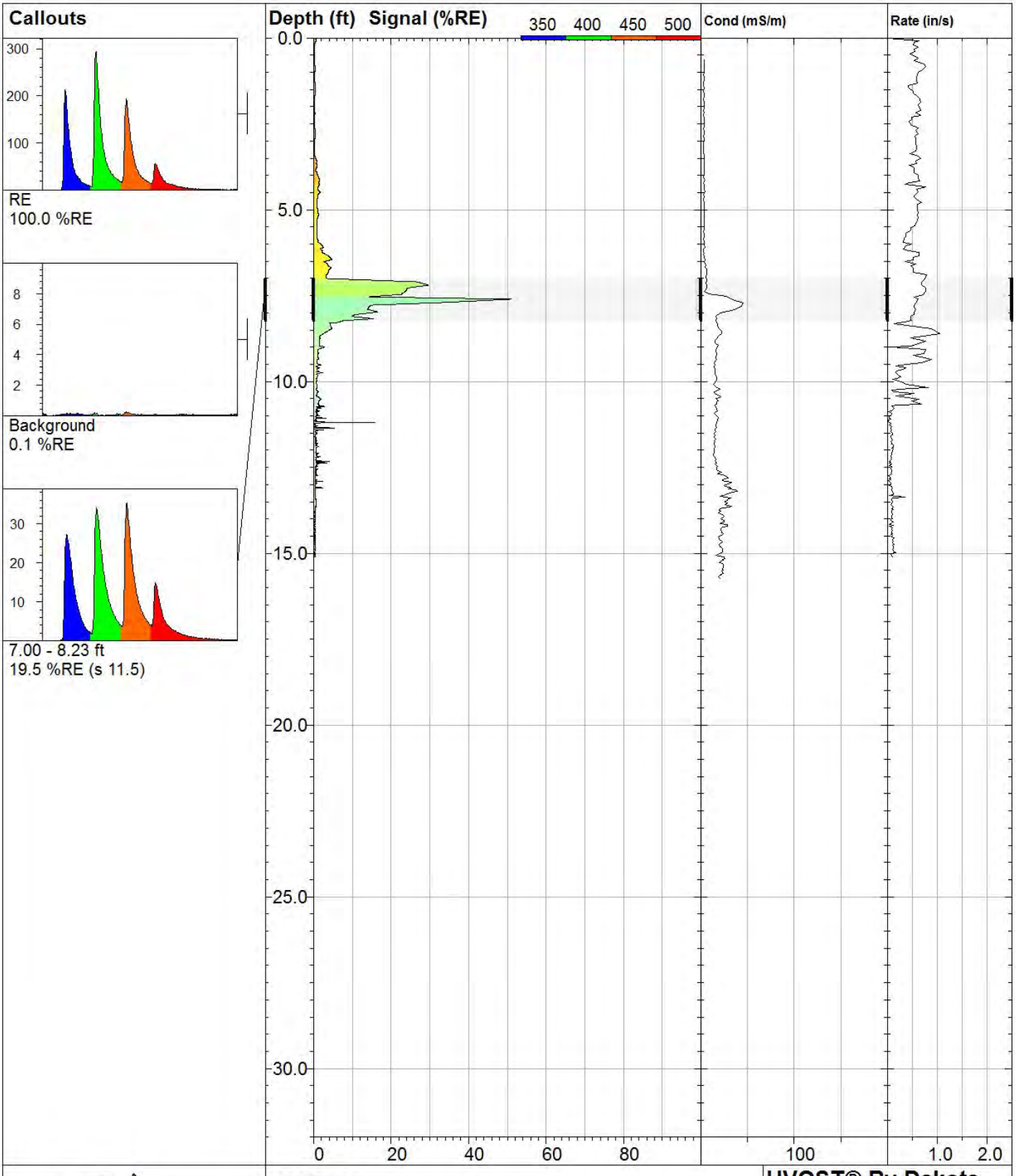
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **26.21 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **20.2 %RE @ 7.55 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 14:35 CDT**



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LIF-4A

UVOST® By Dakota
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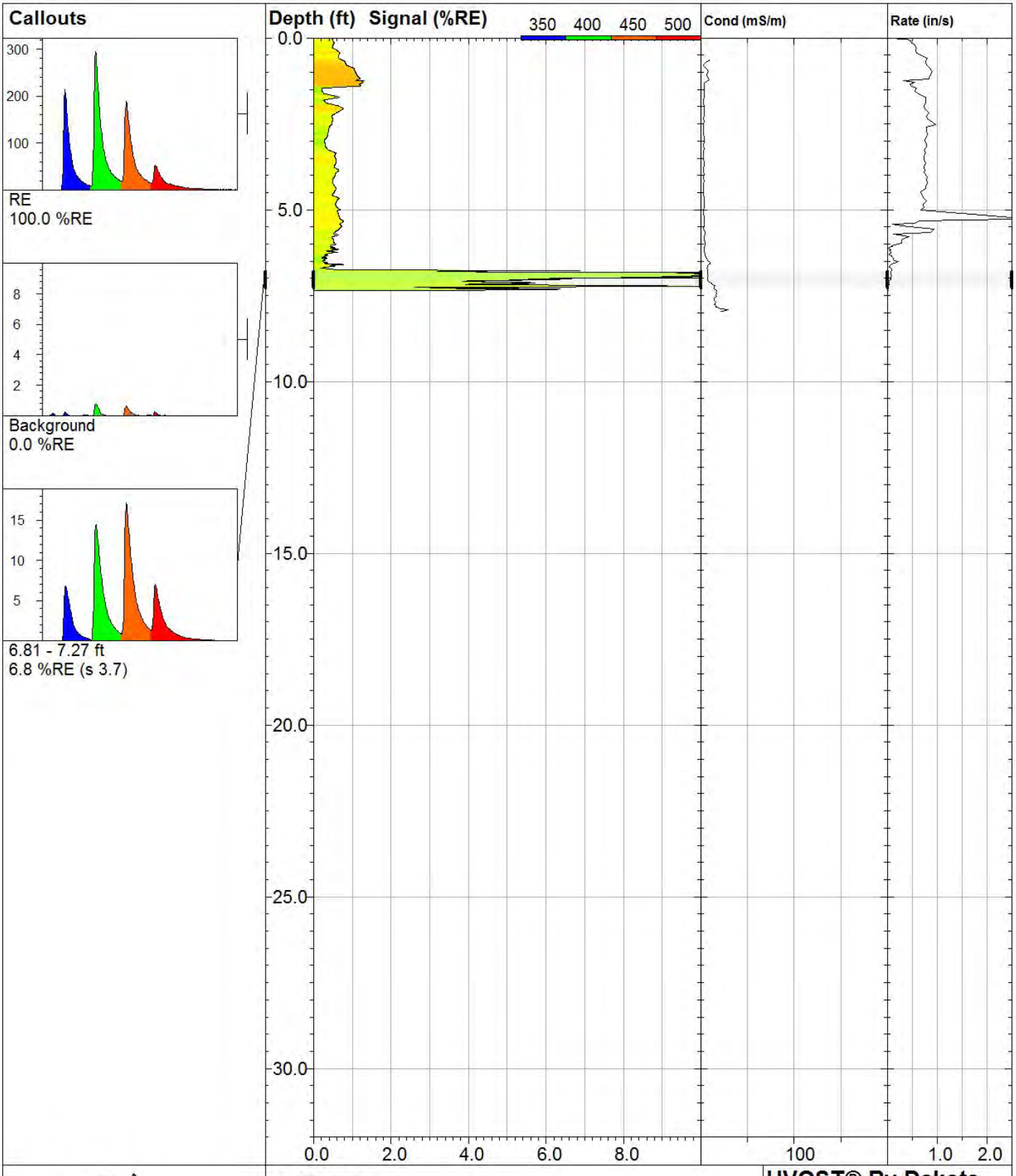
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **15.11 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **51.2 %RE @ 7.60 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 11:54 CDT**

Appendix C

UVOST® Logs at 10% RE



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LIF-01

UVOST® By Dakota
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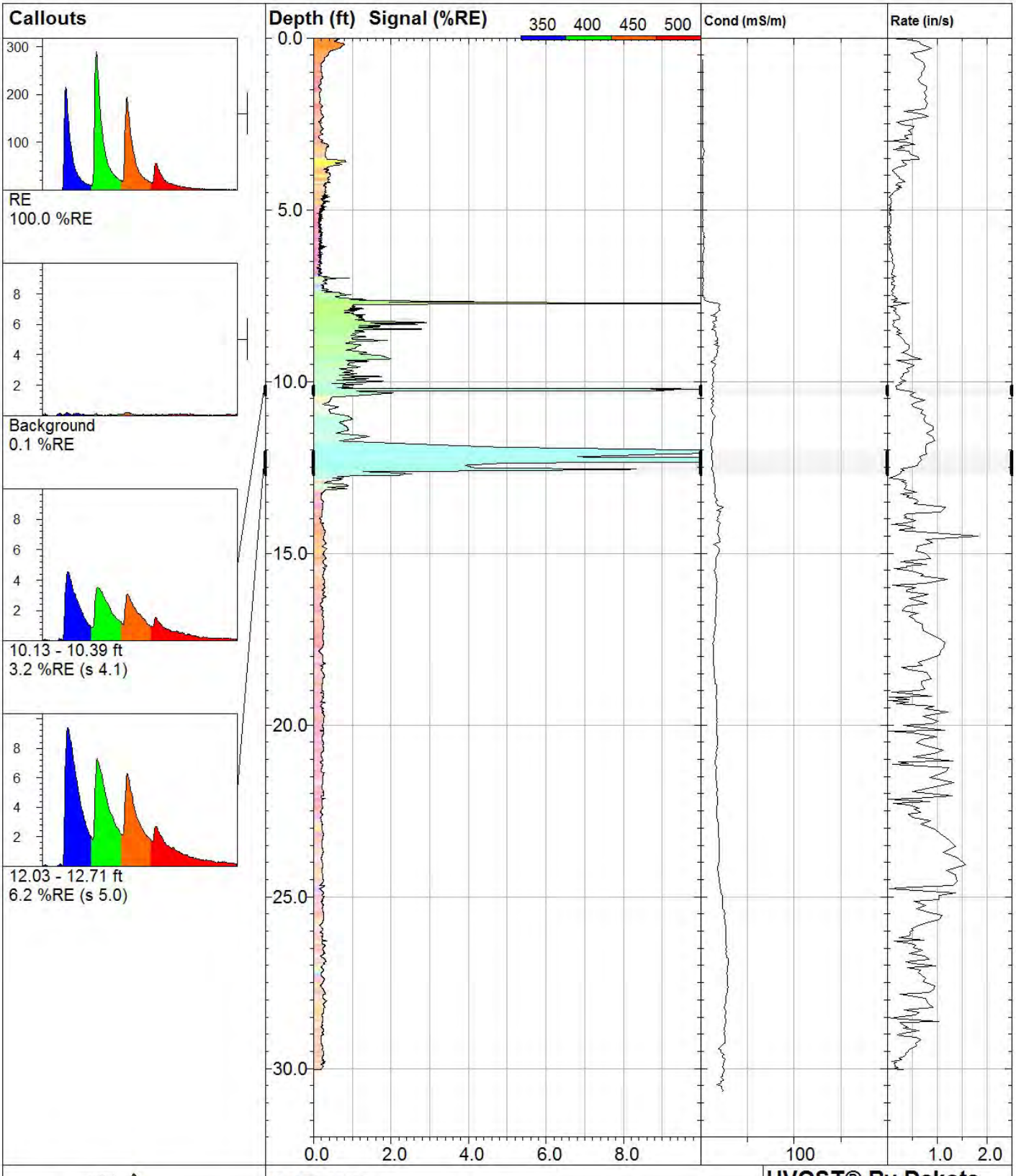
Site: **Haskell Lake**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **7.35 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **22.7 %RE @ 7.24 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 10:00 CDT**



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LIF-02

UVOST® By Dakota
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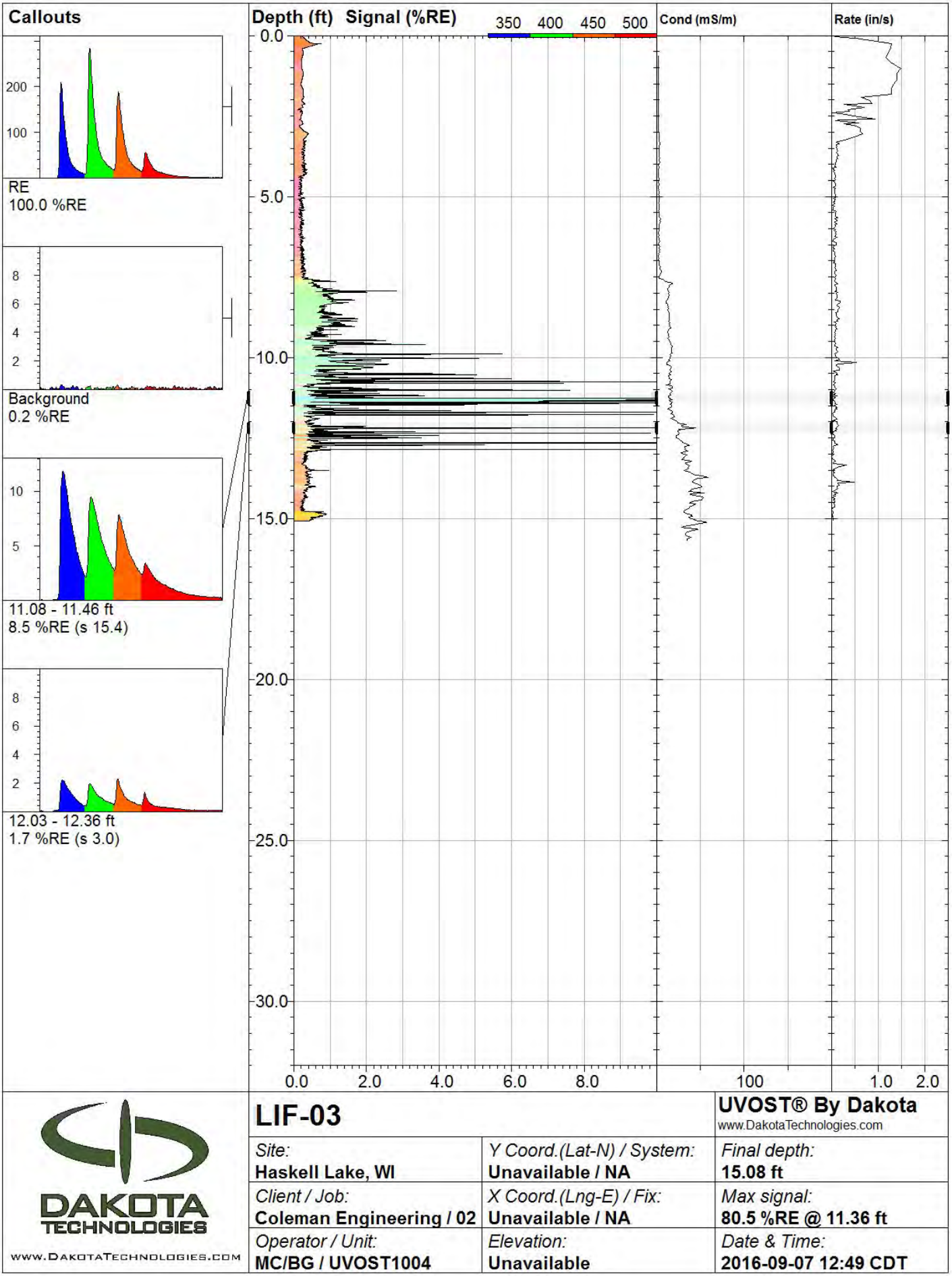
Site: **Haskell Lake**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **30.04 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **19.9 %RE @ 12.28 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 11:45 CDT**



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LIF-03

UVOST® By Dakota
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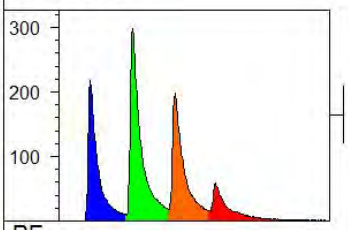
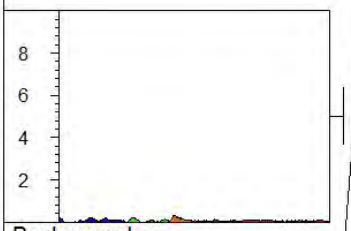
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **15.08 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **80.5 %RE @ 11.36 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 12:49 CDT**

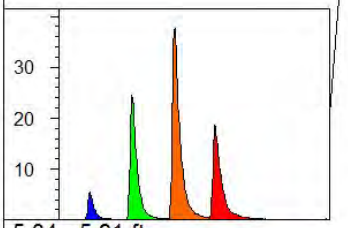
Callouts



RE
100.0 %RE

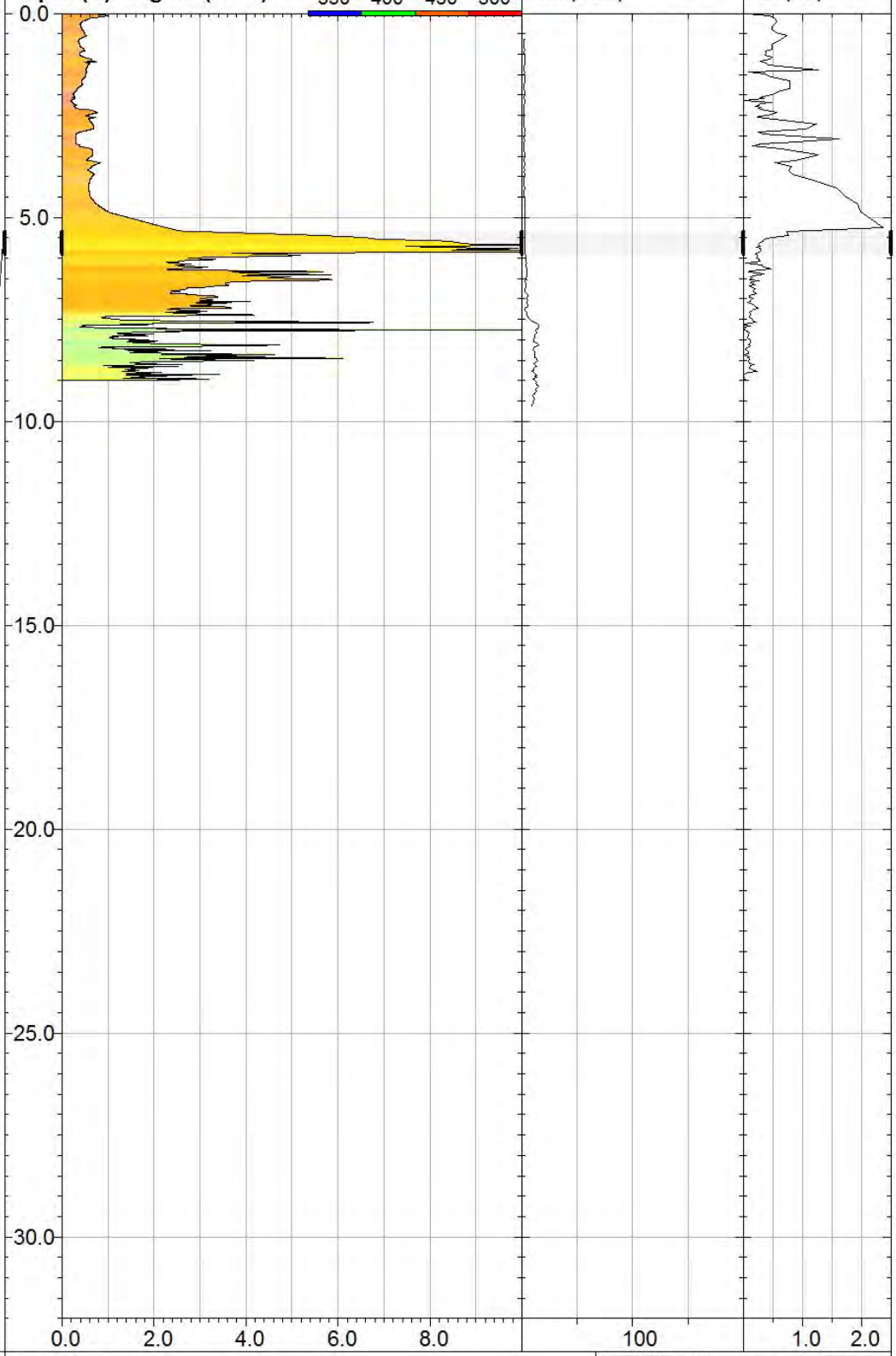


Background
0.2 %RE



5.34 - 5.91 ft
7.7 %RE (s 2.7)

Refusal at 9.00 feet.



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LIF-04

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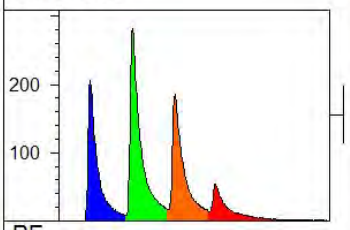
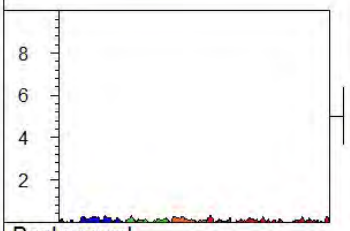
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **9.00 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **15.7 %RE @ 7.75 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 15:35 CDT**

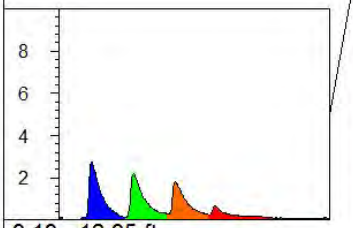
Callouts



RE
100.0 %RE

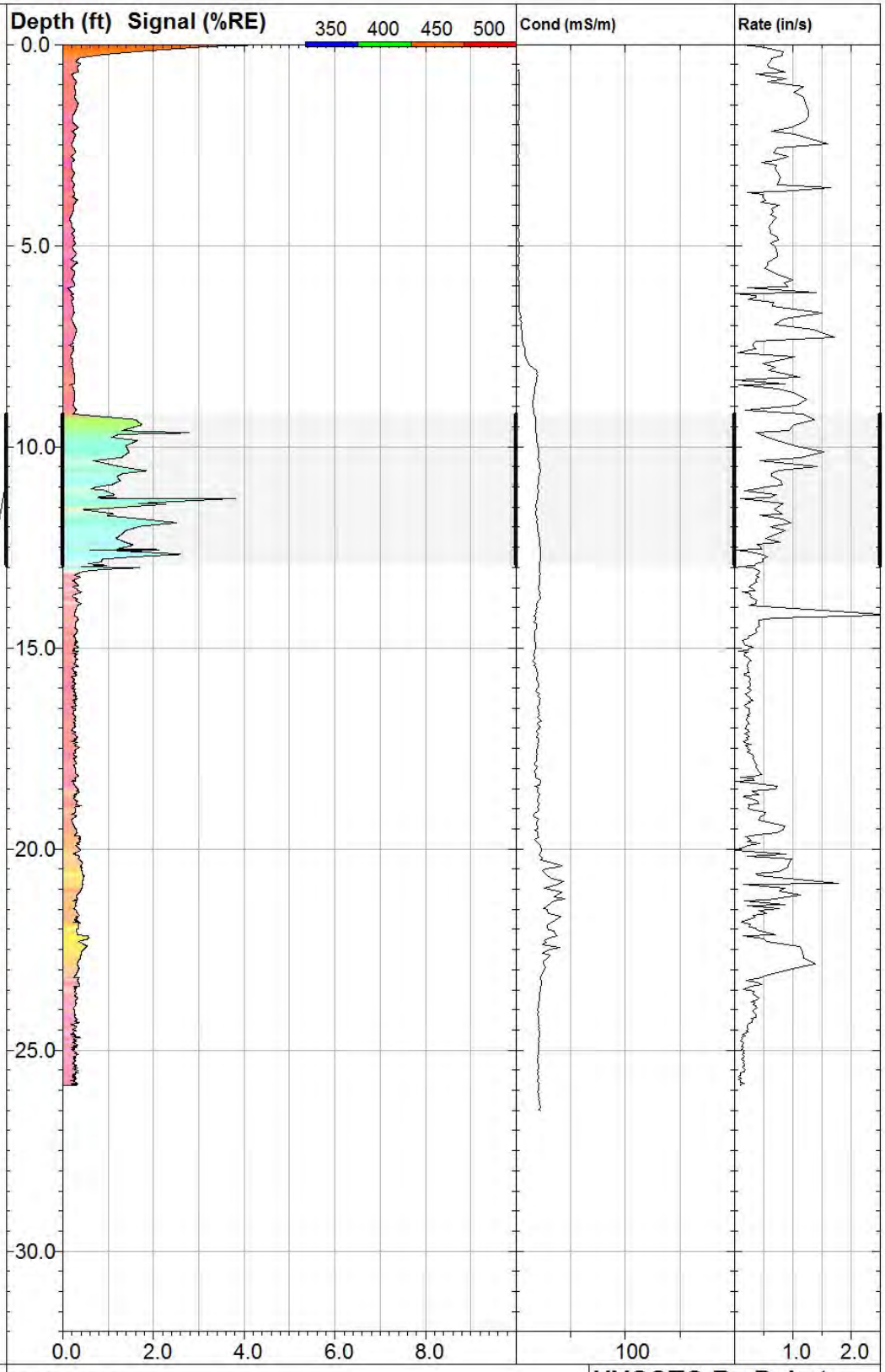


Background
0.2 %RE



9.19 - 12.95 ft
1.4 %RE (s 0.7)

Refusal at 9.00 feet.



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LIF-05

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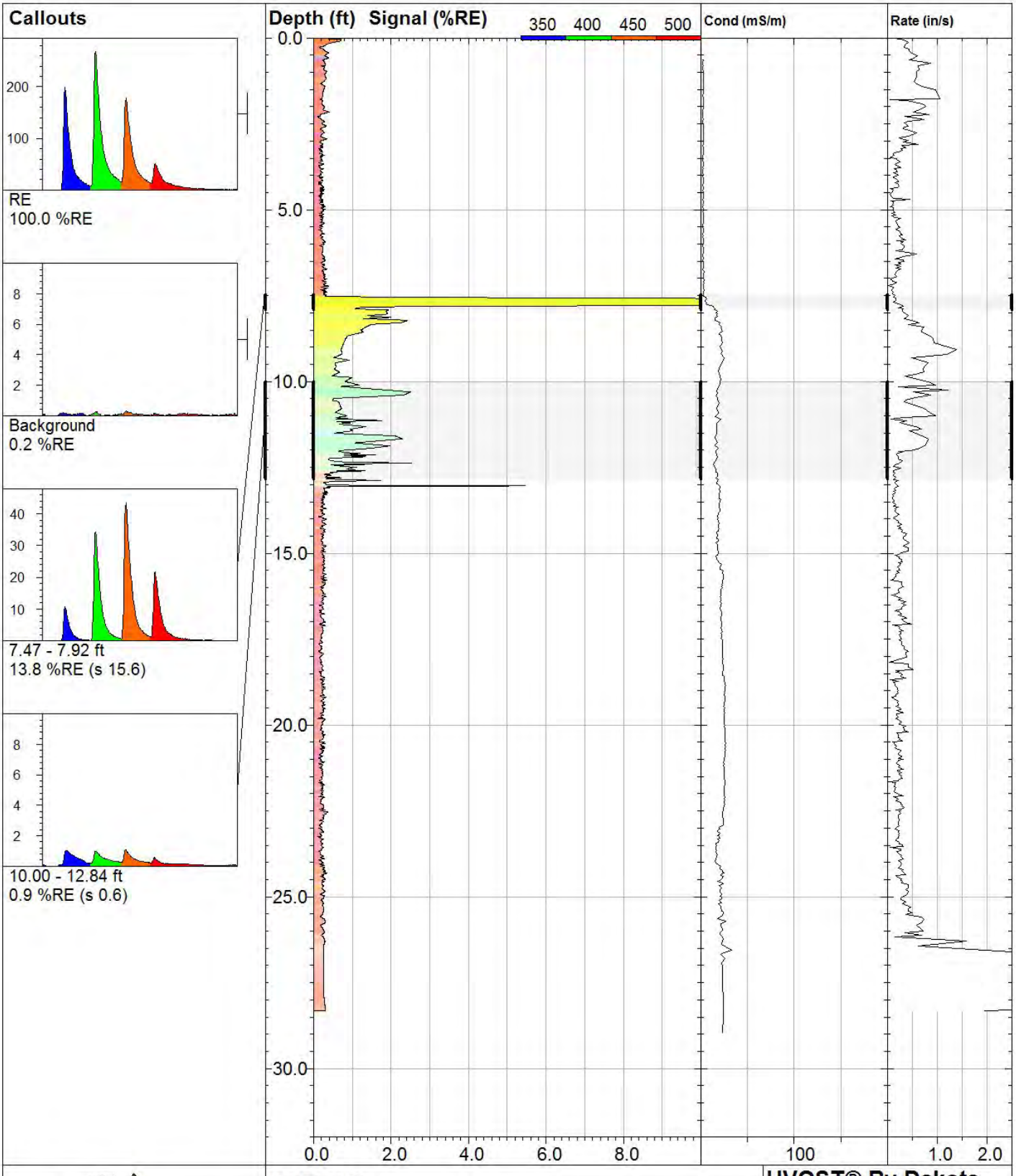
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **25.88 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **4.3 %RE @ 0.01 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 16:32 CDT**



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LIF-06

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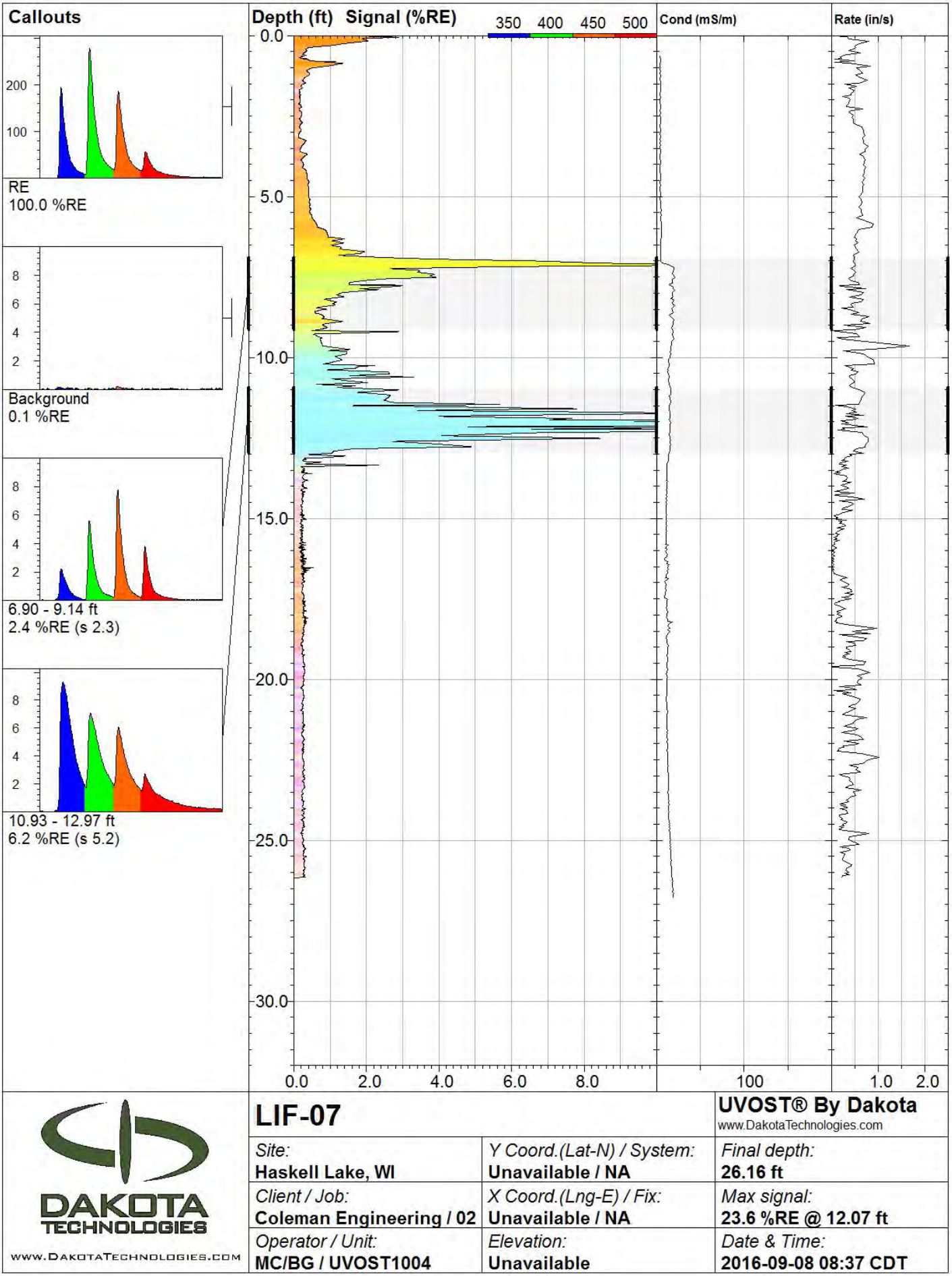
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **28.32 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **44.8 %RE @ 7.70 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 17:13 CDT**



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LIF-07

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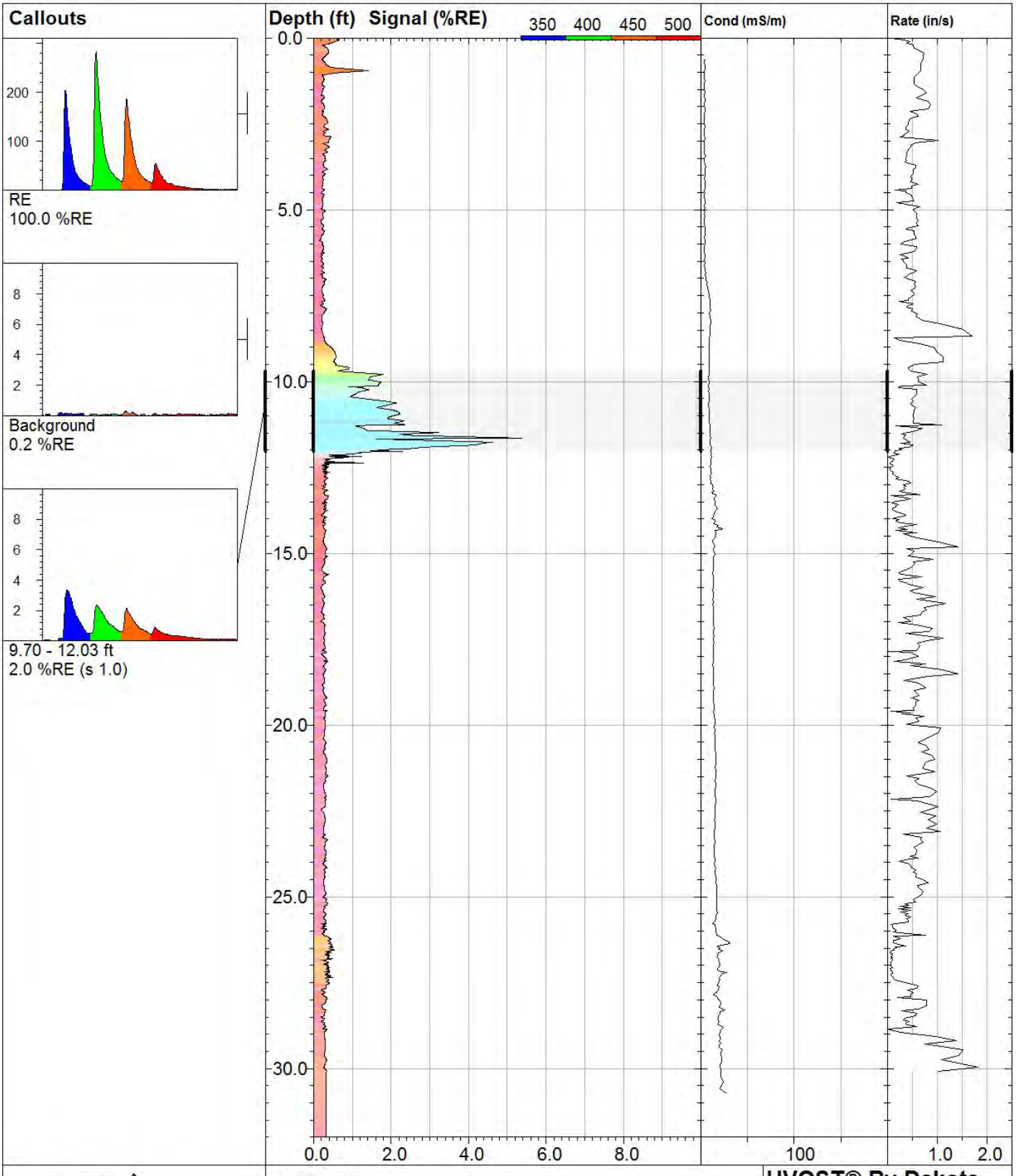
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **26.16 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **23.6 %RE @ 12.07 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 08:37 CDT**



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LIF-08

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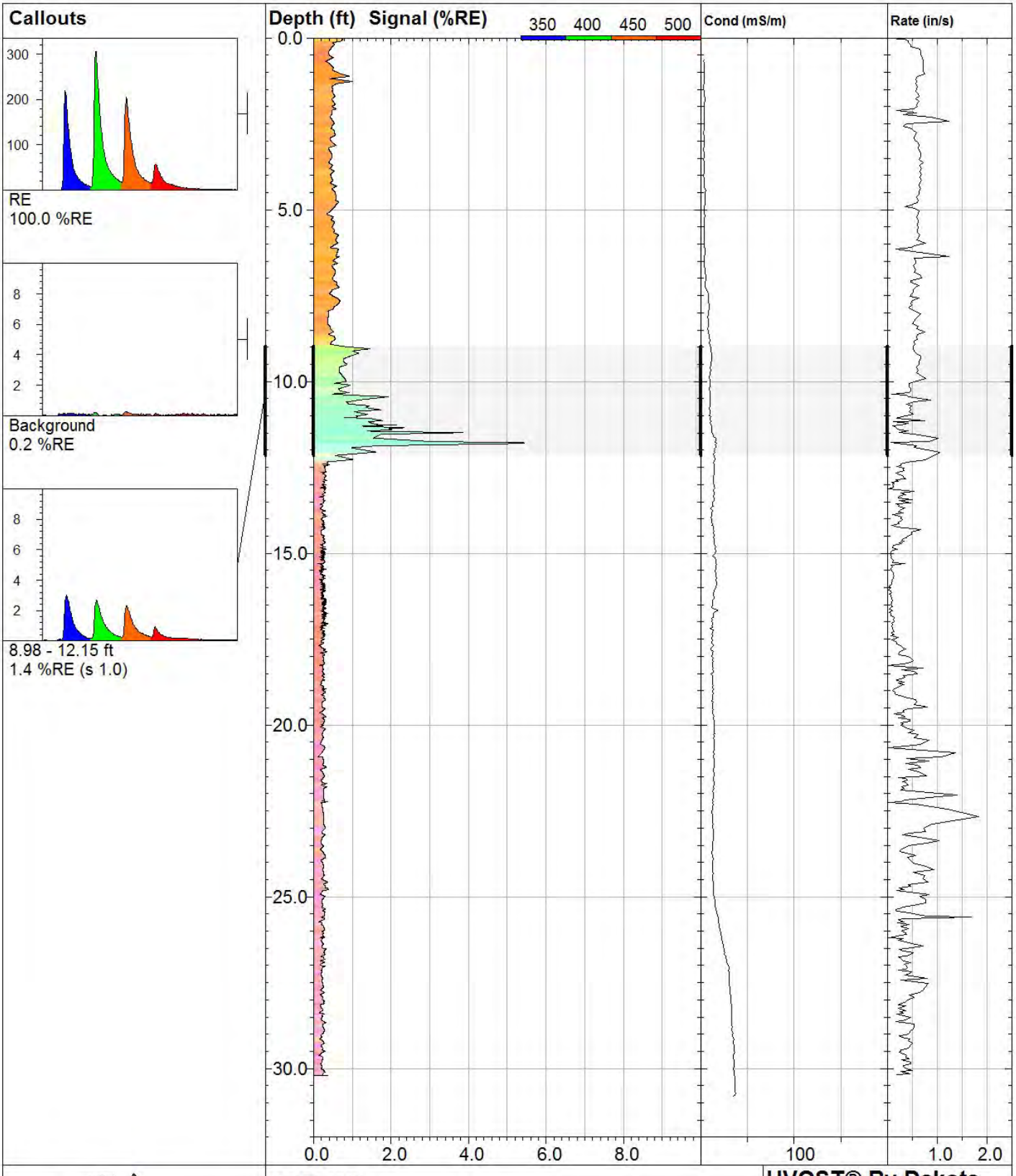
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **32.13 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.4 %RE @ 11.65 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 09:21 CDT**



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LIF-09

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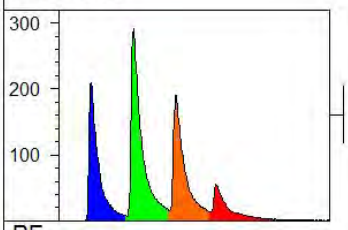
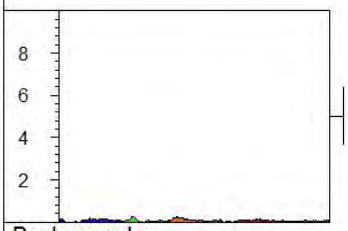
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **30.21 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.5 %RE @ 11.78 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 11:11 CDT**

Callouts

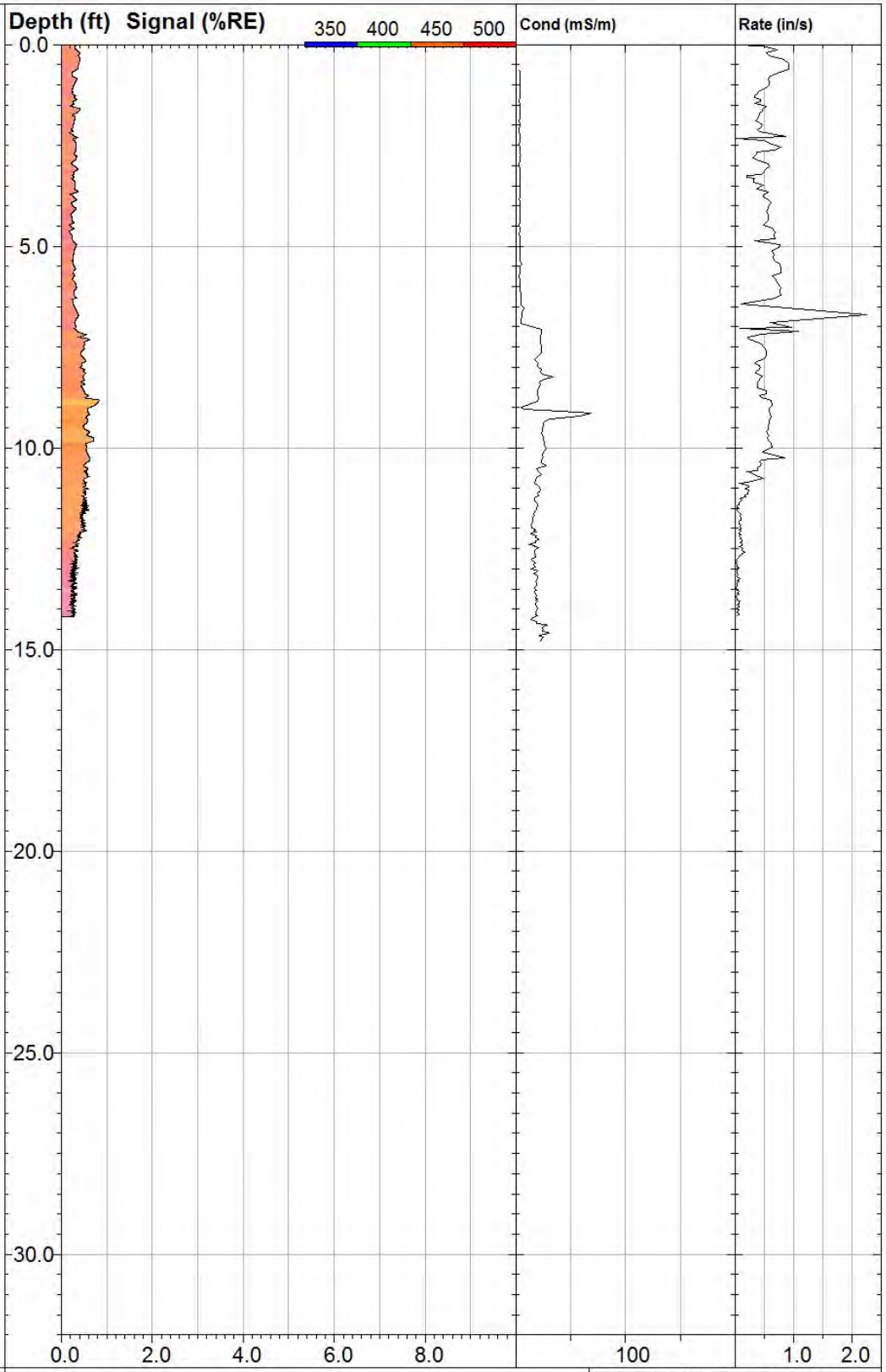


RE
100.0 %RE



Background
0.2 %RE

Refusal at 14.18'.



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LIF-10

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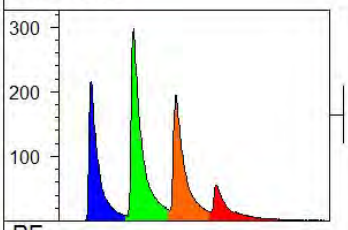
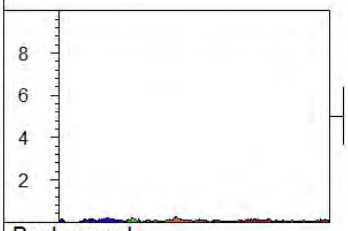
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.18 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **0.8 %RE @ 8.82 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 12:44 CDT**

Callouts

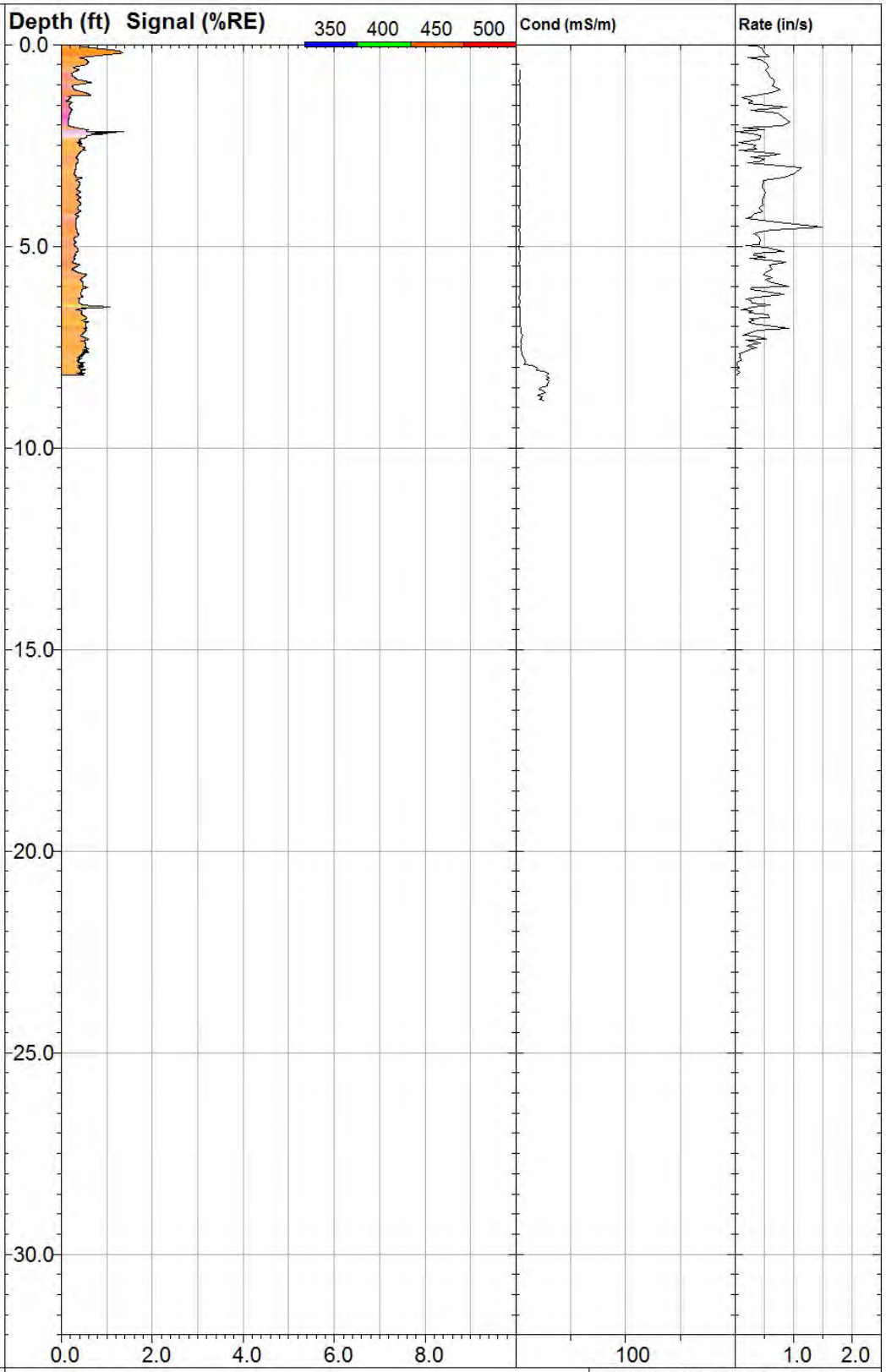


RE
100.0 %RE



Background
0.2 %RE

Refusal at 8.20 feet.



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LIF-11

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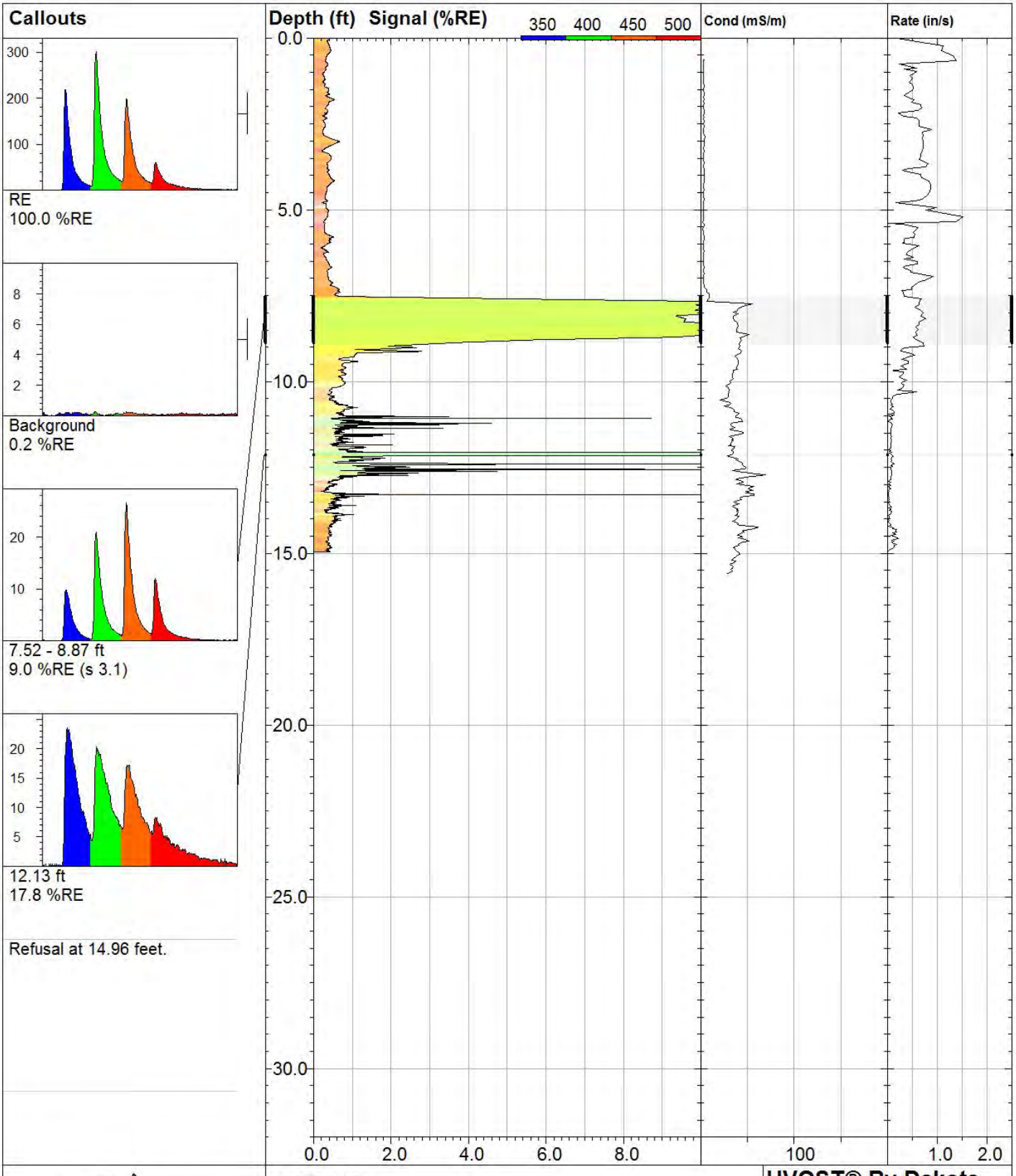
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **8.20 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.4 %RE @ 2.16 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 13:24 CDT**



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LIF-12

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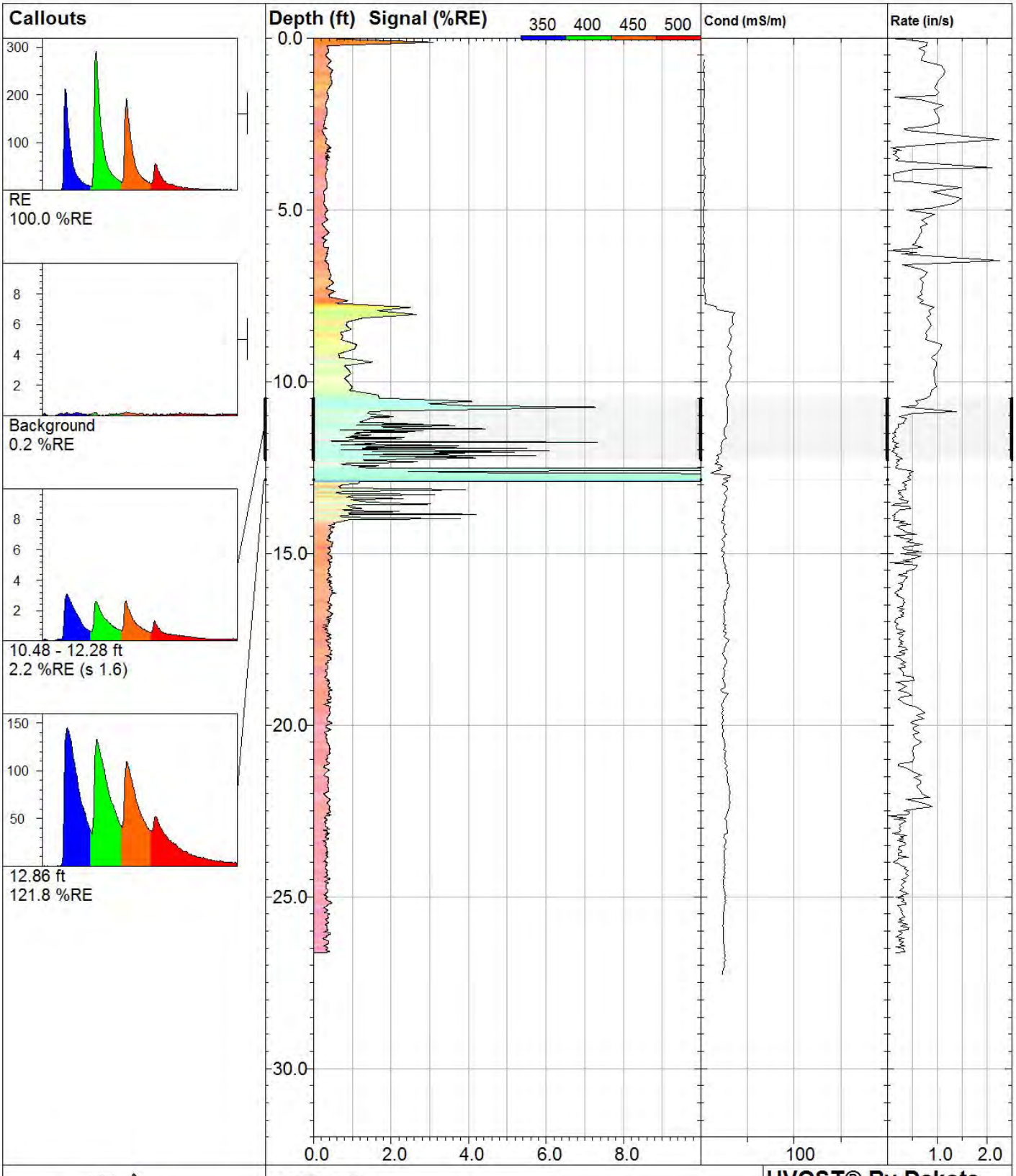
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.96 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **70.2 %RE @ 12.12 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 13:51 CDT**



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LIF-13

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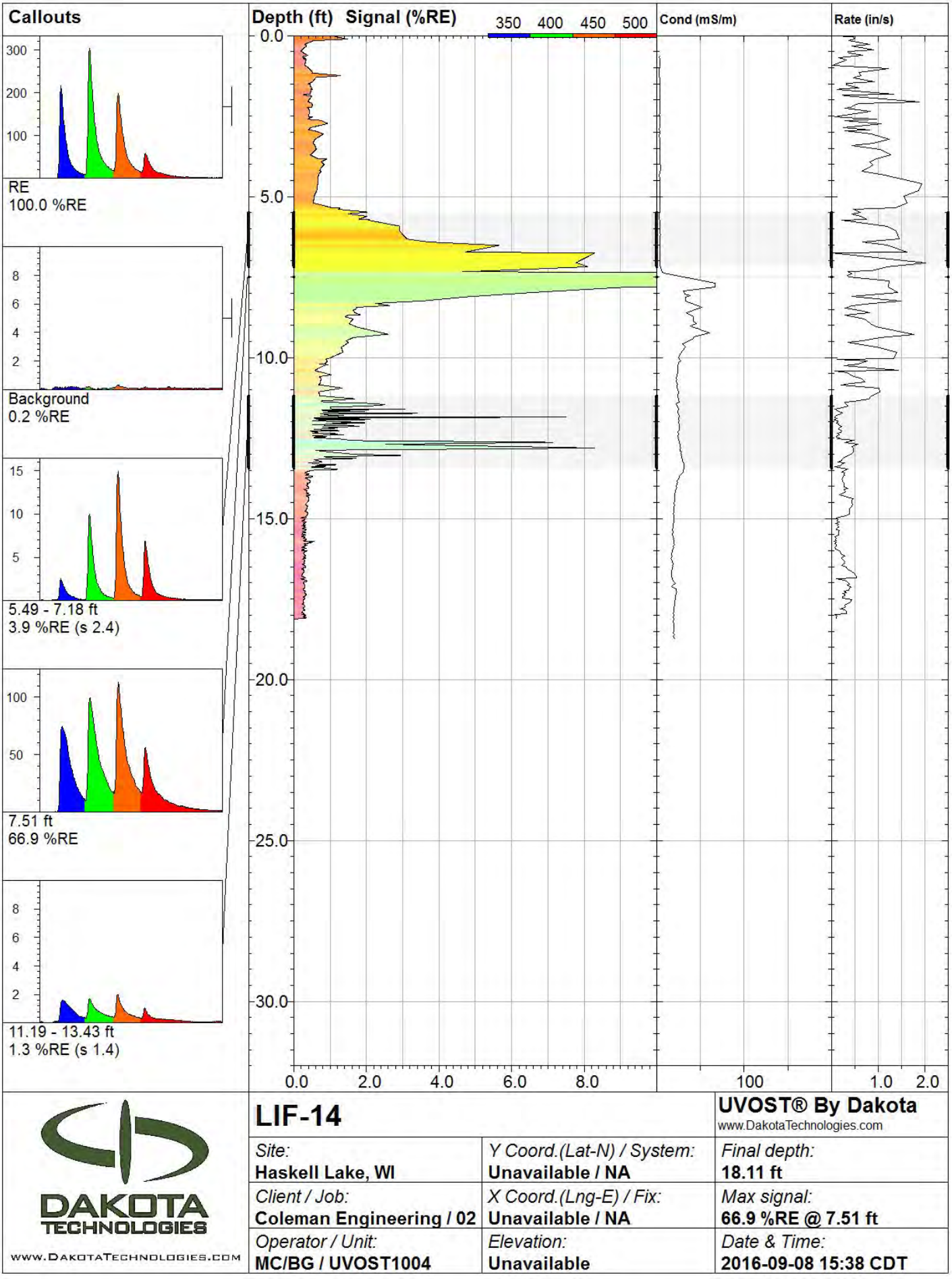
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **26.62 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **121.8 %RE @ 12.86 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 14:49 CDT**



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LIF-14

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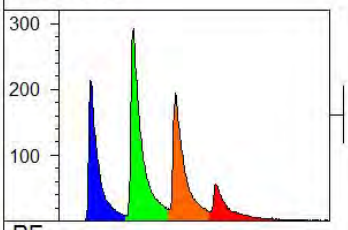
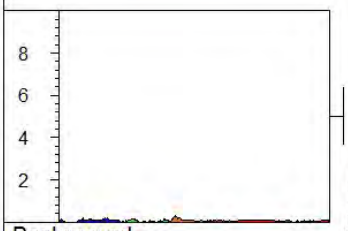
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **18.11 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **66.9 %RE @ 7.51 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 15:38 CDT**

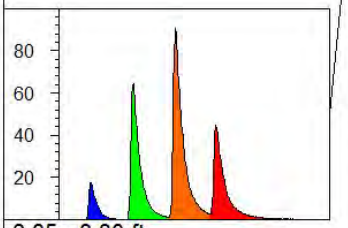
Callouts



RE
100.0 %RE

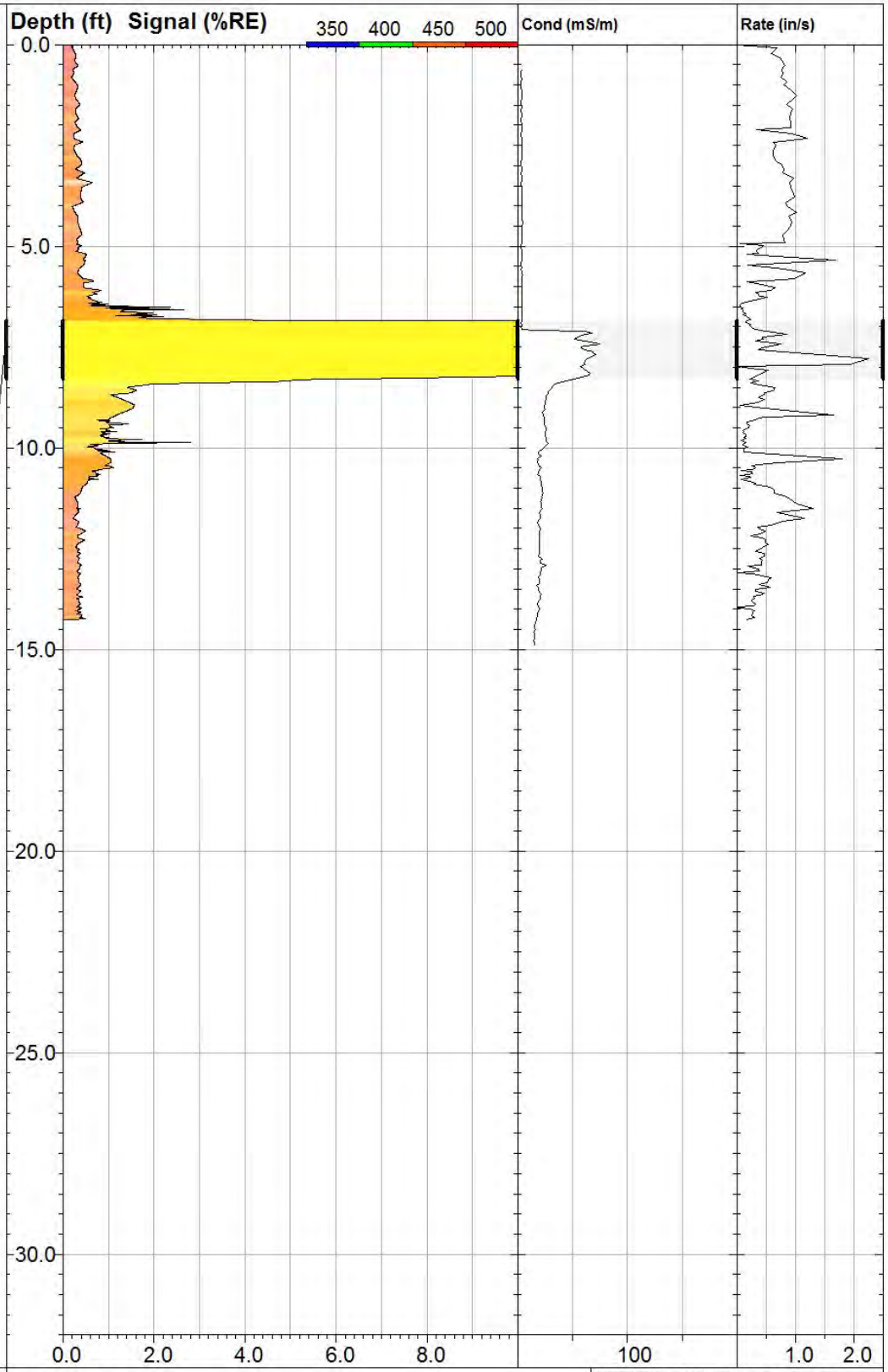


Background
0.2 %RE



6.85 - 8.30 ft
25.2 %RE (s 16.4)

Refusal at 14.27 feet.



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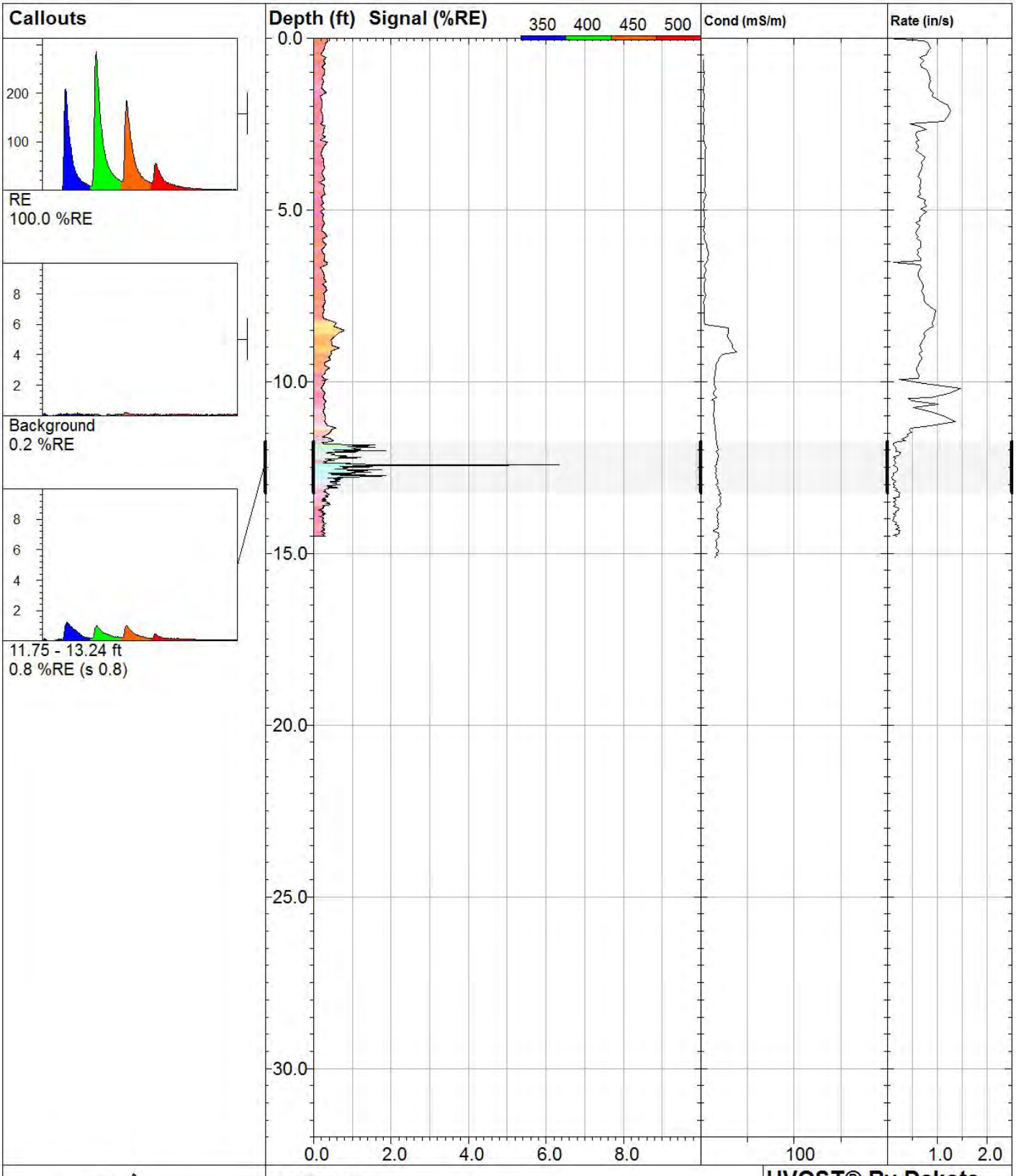
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.27 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **93.5 %RE @ 6.88 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 16:27 CDT**



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LIF-16

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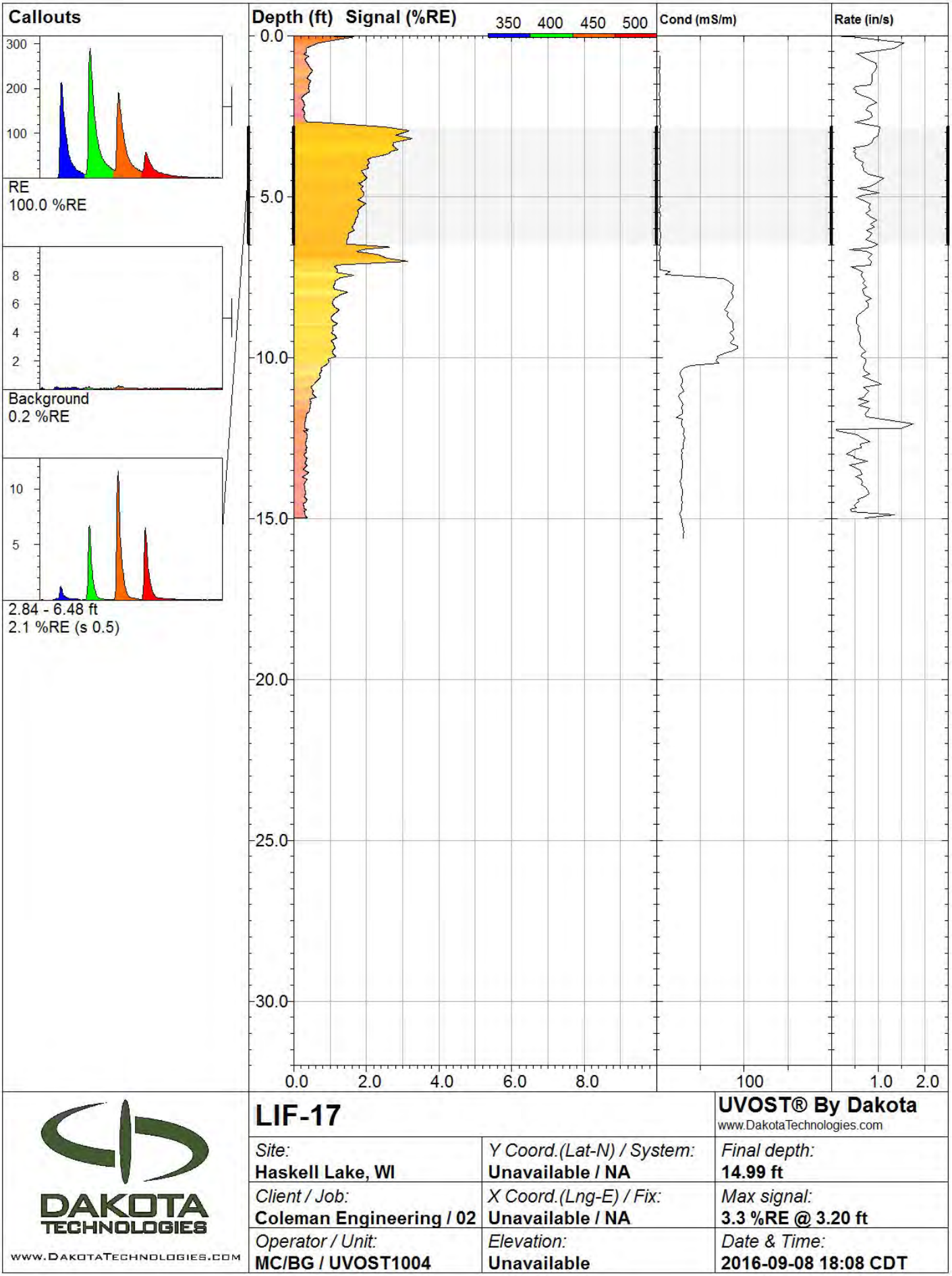
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.51 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.7 %RE @ 12.43 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 17:11 CDT**



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LIF-17

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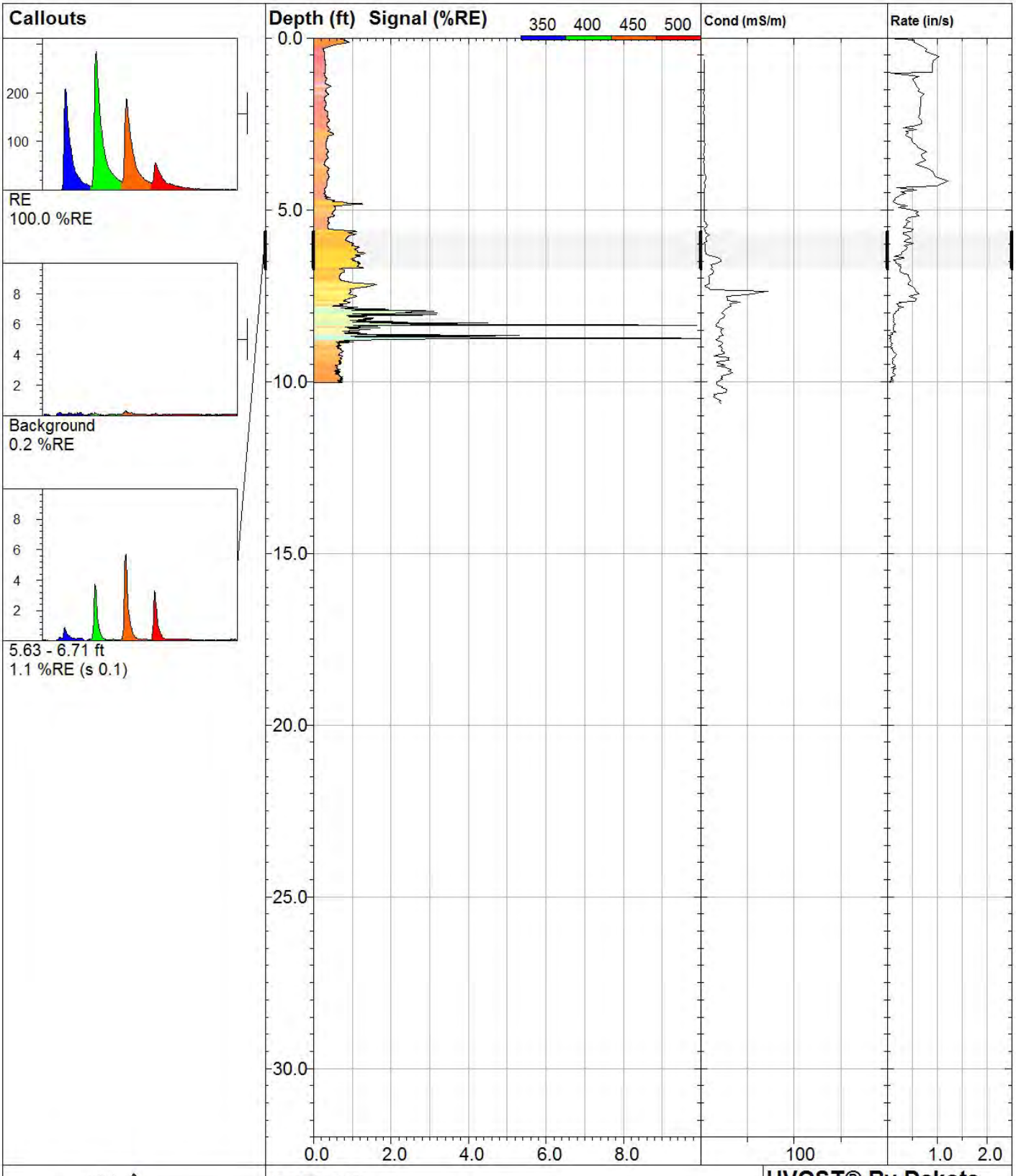
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **14.99 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **3.3 %RE @ 3.20 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 18:08 CDT**



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LIF-18

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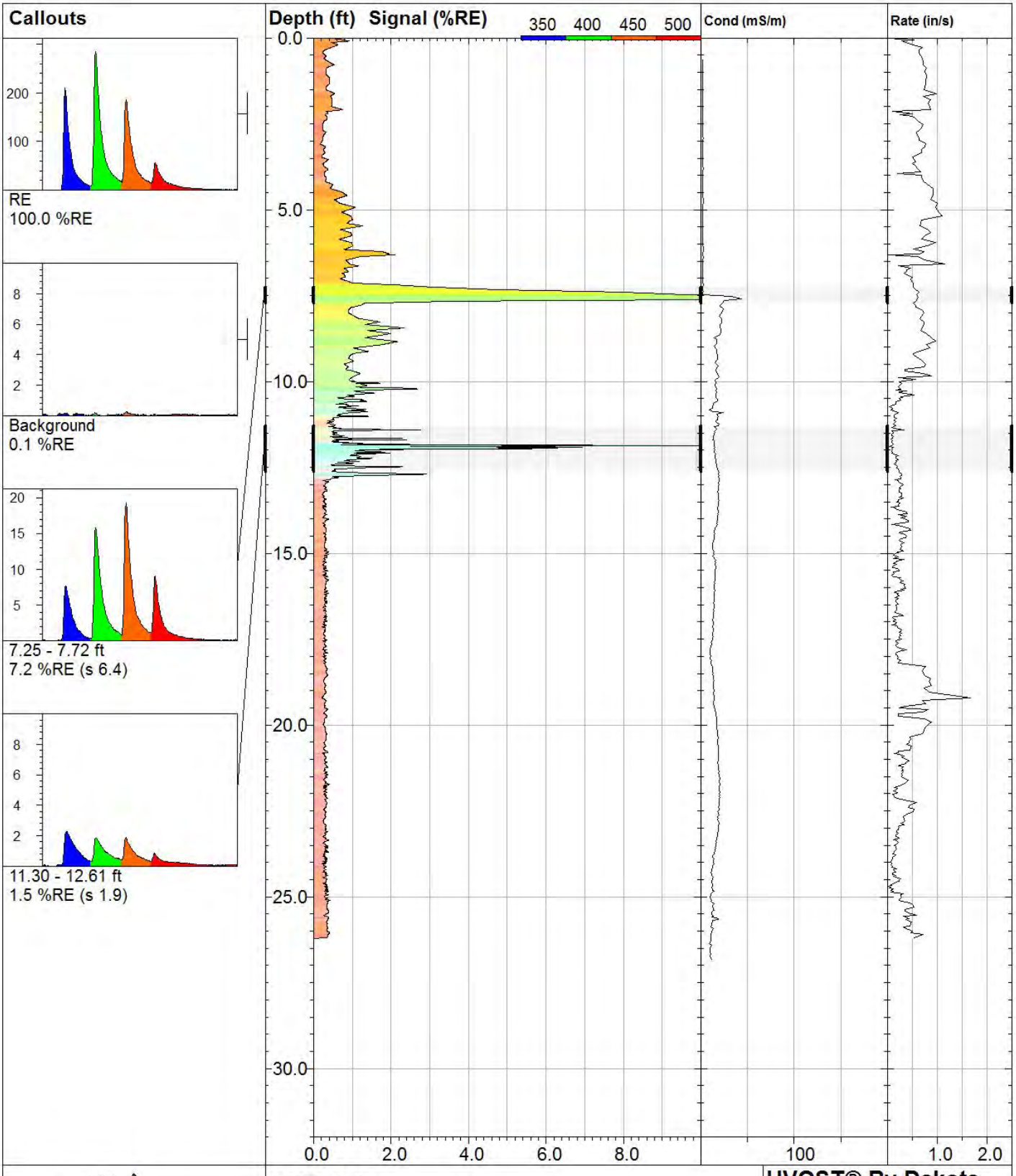
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **10.04 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **10.6 %RE @ 8.74 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 18:31 CDT**



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LIF-1A

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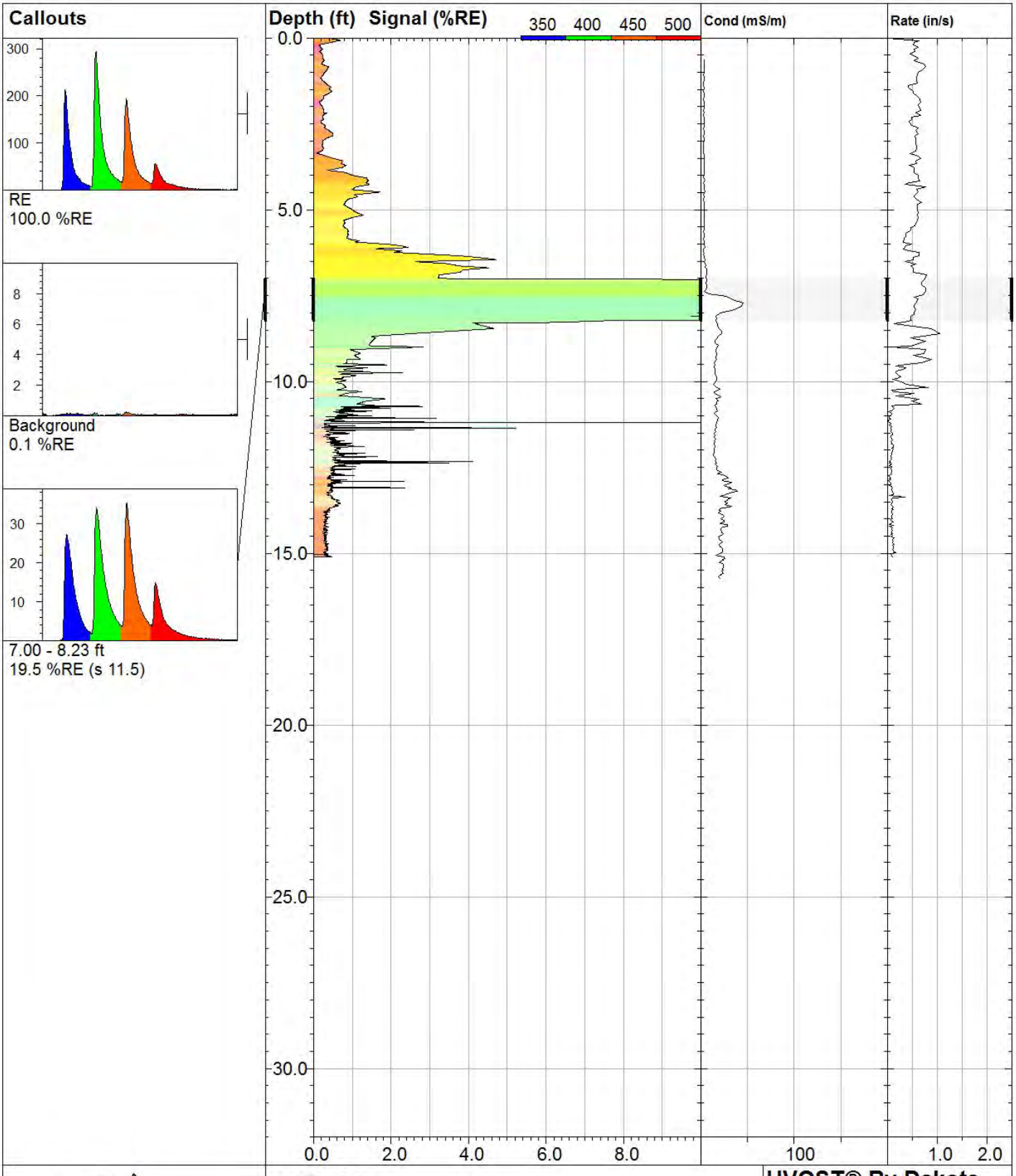
Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **26.21 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **20.2 %RE @ 7.55 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-07 14:35 CDT**



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LIF-4A

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Site: **Haskell Lake, WI**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **15.11 ft**
Client / Job: **Coleman Engineering / 02**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **51.2 %RE @ 7.60 ft**
Operator / Unit: **MC/BG / UVOST1004**	*Elevation:* **Unavailable**	*Date & Time:* **2016-09-08 11:54 CDT**

Appendix D

UVOST® Reference Log

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UVOST® Reference Log

Main Plot:
Signal (total fluorescence) versus depth where signal is relative to the Reference Emitter (RE). The total area of the waveform is divided by the total area of the Reference Emitter yielding the %RE. This %RE scales with the NAPL fluorescence. The fill color is based on relative contribution of each channel's area to the total waveform area (see callout waveform). The channel-to-color relationship and corresponding wavelengths are given in the upper right corner of the main plot.

Callouts:
Waveforms from selected depths or depth ranges showing the multi-wavelength waveform for that depth. The four peaks are due to fluorescence at four wavelengths and referred to as “channels”. Each channel is assigned a color.

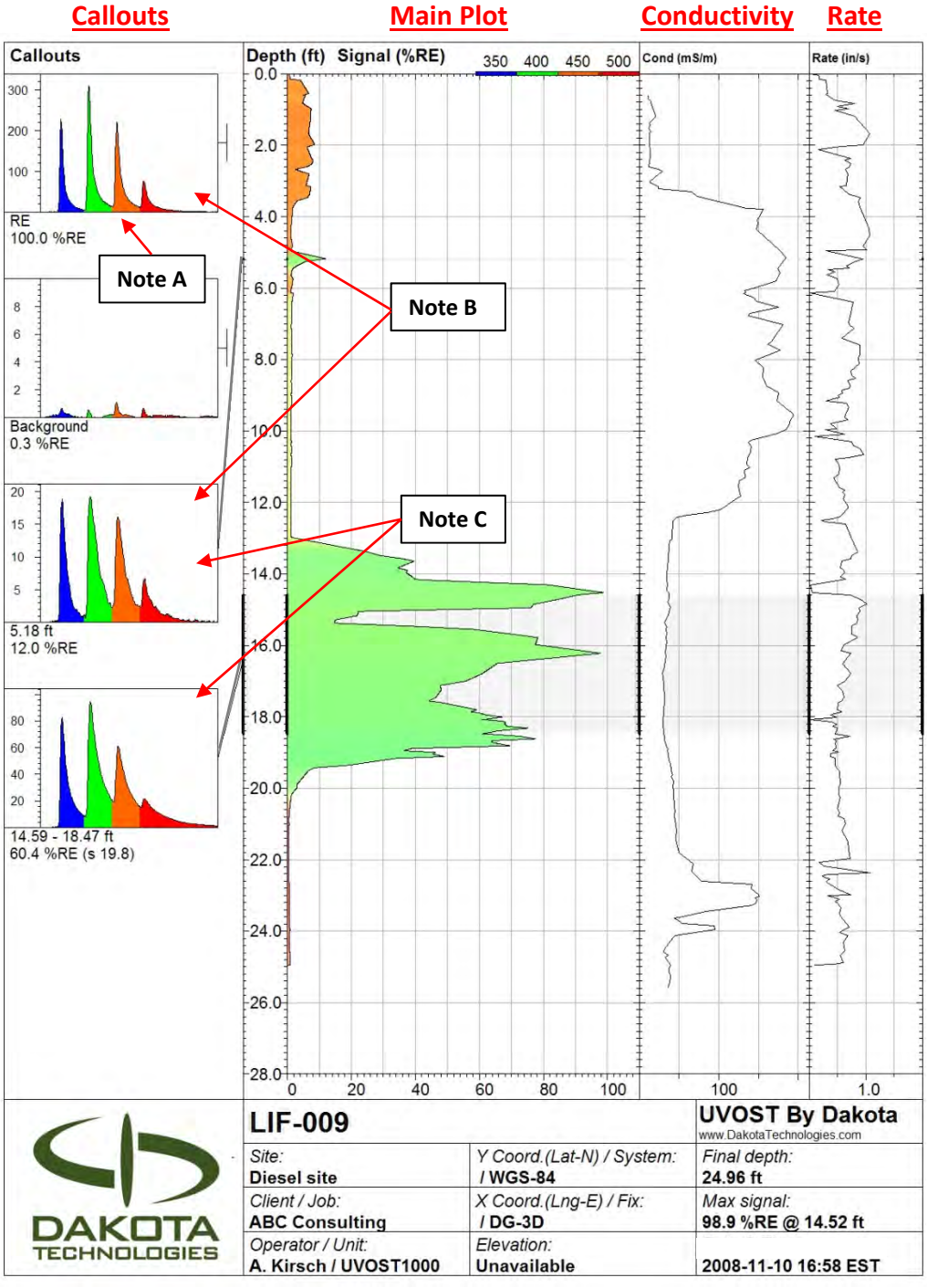
Various NAPLs will have a unique waveform "fingerprint“ due to the relative amplitude of the four channels and/or broadening of one or more channels. Basic waveform statistics and any operator notes are given below the callout.

Conductivity Plot:
The Electrical Conductivity (EC) of the soil can be logged simultaneously with the UVOST data. EC often provides insight into the stratigraphy. Note the drop in EC from 10 to 13 feet, indicating a shift from finer (clay) to larger grain size (sand) stratigraphy. This correlates with the observed NAPL distribution.

Rate:
The rate of probe advancement. Approx. 0.8 inches (2cm) per second is preferred. A noticeable decrease in the rate of advancement may be indicative of difficult probing conditions (gravel, angular sands, etc.) such as that seen here at approx. 5 ft.

Note that this log was terminated arbitrarily, not due to "refusal," which would have been indicated by a sudden rate drop at final depth.

Information Box:
Contains pertinent log information, including name and location.



Note A:
Time is along the x axis. No scale is given on callouts, but it is a consistent 320ns wide. The y axis is in mV and directly corresponds to the amount of light striking the photodetector.

Note B:
These two waveforms are clearly different. The top box is the Reference Emitter (a blend of NAPLs) always taken before each log for calibration, and the lower box is weathered diesel from the log itself.

Note C:
Callouts can be a single depth (see 3rd callout) or a range (see 4th callout). The range is noted on the depth axis by a bold line. When the callout is a range, the average and standard deviation in %RE is given below the callout.

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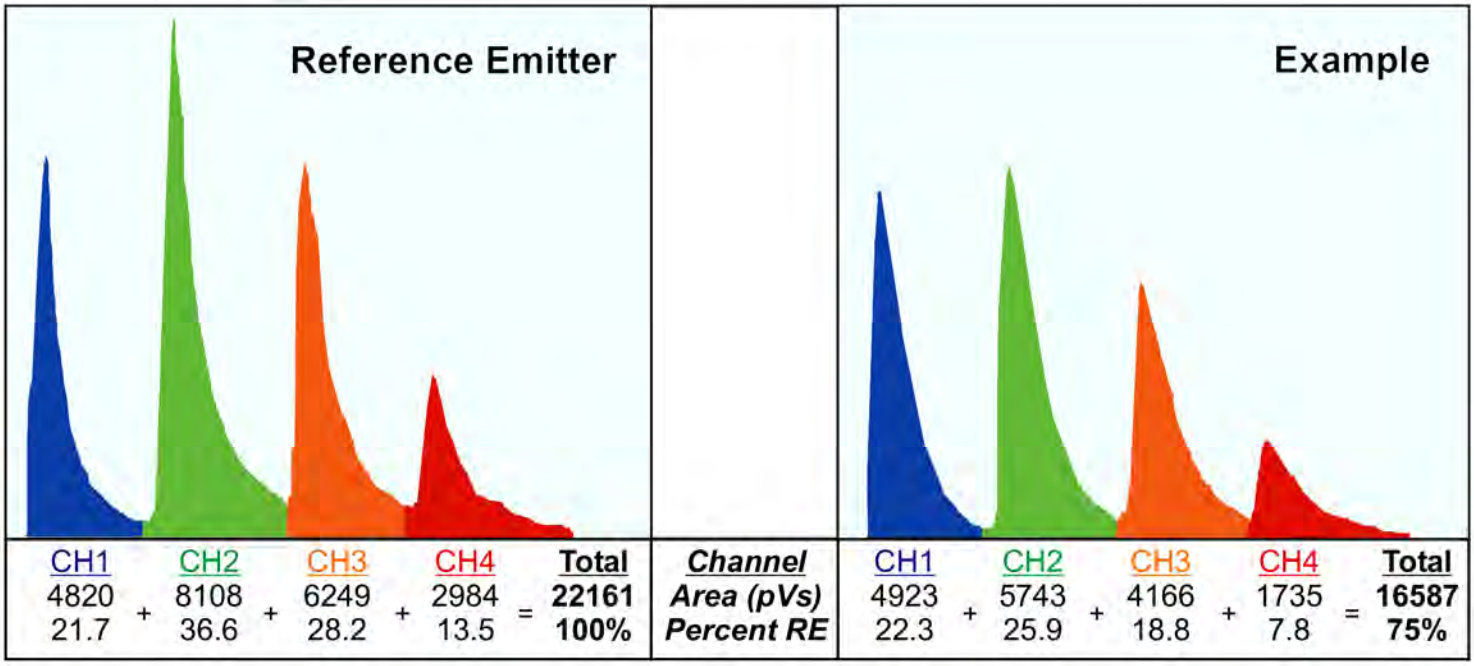
UVOST® Reference Log

Waveform Signal Calculation



Data Files

***.lif.raw.bin**	Raw data file. Header is ASCII format and contains information stored when the file was initially written (e.g. date, total depth, max signal, GPS, etc., and any information entered by the operator). All Raw waveforms are appended to the bottom of the file in a binary format.
***.lif.plt**	Stores the plot scheme history (e.g. callout depths) for associated Raw file. Transfer along with the Raw file in order to recall previous plots.
***.lif.jpg**	A .jpg image of the OST log including the main signal vs. depth plot, callouts, information, etc.
***.lif.dat.txt**	Data export of a single Raw file. Tab delimited format. No string header is provided for the columns to make importing into some programs easier. Each row is a unique depth reading. The columns are: 1-Depth; 2-Total Signal (%RE); 3-CH1%; 4-Ch2%; 5-CH3%; 6-Ch4%; 7-Rate; 8-EC Depth; 9-EC Signal; 10-Hammer Rate Depth; 11-Hammer Rate; 12-Color (RRGGBB). Summing channels 1 to 4 yields the Total Signal.
***.lif.sum.txt**	A summary file for a number of Raw files. ASCII tab delimited format. The file contains a string header. The summary includes one row for each Raw file and contains information for each filed including: the file name, GPS coordinates, max depth, max signal, and depth at which the max signal occurred.
***.lif.log.txt**	An activity log generated automatically is located in the OST application directory in the 'log' subfolder. Each OST unit the computer operates will generate a separate log file per month. A log file contains much of the header information contained within each separate Raw file, including: data rate, total depth, max signal, etc.

Common Waveforms (highly dependent on soil, weathering, etc.)